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Building Bridges: The Role of an Undergraduate Mentor

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ABSTRACT

I share some advice and lessons that I have learned from working with many wonderful students and colleagues, in my role as Undergraduate Chair of Statistics at Purdue University since 2008. I also reflect on developing, implementing, and sustaining a new living, learning community environment for statistics students.

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1. Introduction: Perspectives on Undergraduate Mentoring

Much of this advice has been garnered since 2008, when I became Undergraduate Chair of Statistics at Purdue. Since that time, our undergraduate program has doubled in size and is one of the largest statistics undergraduate programs in the United States. In fall 2014, we introduced a National Science Foundation initiative called “Sophomore Transitions: Bridges into a Statistics Major and Big Data Research Experiences via Learning Communities.” Implementing this grant’s activities has caused me to think a lot about the many aspects of mentoring, especially mentoring undergraduate students in statistics.

I see the role of a mentor as someone who walks alongside students (rather than leading or pushing them) over many bridges in the early part of their career. A mentor often lends a helping hand or provides a kleenex. Sometimes mentors simply provide advice or alternative viewpoints for the student.

To be an effective mentor, it is helpful to have many attributes that are not specific to being a statistician. For example, it is necessary to be forgiving, patient, and willing to listen. Mentees need the freedom to be able to fail and then keep going, without being disgraced. It is necessary to occasionally speak strongly on behalf of mentees, to help them remove a roadblock. It is also necessary to be available for mentees, to spend time with them, to respond in a timely manner to messages, and to earnestly desire to help one’s mentees.

Even mentors need mentors themselves, so it is necessary to know when to seek broader advice from others, and when to use resources that a mentee might not know about. It is helpful to always put things into a larger context, and to help mentees to expand and test their boundaries.

Steve Shatz (Professor of Mathematics, Emeritus, in the Department of Mathematics at the University of Pennsylvania) told me (while I was a postdoc) that there is no such thing as “teaching,” but there is such a thing as “learning.” I was a little discouraged, at first, at this news, but I am gradually

understanding what he meant. Being (a) mentors and (b) professors means that we can expose students to many ideas that they might not have known about otherwise. It is they, however, who hone their skills by continual practice in exercises and internalize the ideas we have presented. We can, at best, broaden their view of the scientific landscape, and then help guide students as they explore a discipline.

At the end of a student’s degree, mentors help students find the right jobs and opportunities. Graduate school should not automatically be the next step for every undergraduate student. I have cold-called HR offices on behalf of students, and this has led to job offers that the mentees would not have obtained themselves. It is important to be willing to match a mentee to a job that is a great fit for that individual (not just what looks best on paper), for example, a job near one’s spouse, for example. The human element plays a surprisingly strong role in such job searches.

2. Welcoming Diversity

Celebrating diversity in science can transform one’s viewpoint. Everyone’s background is unique. Everyone’s viewpoint is unique. Everyone’s input can be valuable. There is no substitute for learning from the diversity of experiences of one’s colleagues.

We can learn from our peers across the STEM disciplines about fostering a welcoming atmosphere. Many faculty in statistics seem unaware of well-known sources about the diversity of student experiences, for instance, Seymour and Hewitt (1997) or Margolis and Fisher (2002). These books help explain why attrition away from STEM disciplines starts at such a young age. I believe it is crucial to encourage students at the earliest stages of learning (not only during K-12, but even before entering school) that computing, mathematics, and statistics are accessible to everyone. Microaggressions and preconceived notions (e.g., about the aptitude of students) become roadblocks to success. The statistics workforce cannot be simply

composed (for instance) only of students with Ph.Ds in theoretical mathematics.

I firmly believe that retention of students is a bigger issue than recruitment. We can recruit many students to the statistics discipline, but unless we provide supportive (albeit rigorous) environments, we will not be able to retain diverse students. It is crucial to have a welcoming environment for students; otherwise, we run the risk of losing the breadth of students in the statistics workforce in the years ahead.

Helping students to build a sense of community is one of a mentor's most important roles. We can do this in our departments, workshops, conferences, and workplaces. A sense of community develops from short individual experiences, and from long-term professional development. It does not happen overnight. Spending time with students—and spending a significant portion of that time just listening to their needs and concerns—is a significant part of community building. I will discuss learning in community in the next section.

I also like to emphasize the human aspects of our scientific endeavors, and the connections with larger issues, such as public policy. As an example, from my colleagues at the NSF funded Center for Coastal Margin Observation & Prediction, I have learned about the perspective of the Native Americans on issues such as the Columbia River Treaty of 1964, which has the possibility of termination after 60 years. If you have never heard of this treaty, I strongly encourage you to read about its many impacts. The lengthy report of the Universities Consortium on Columbia River Governance (Paisley, McKinney, and Stenovc 2015) is a helpful starting point, especially for understanding the broader context of this treaty. I recently became a lifetime member of Society for Advancement of Chicanos and Native Americans in Science (SACNAS). I firmly believe in the need to learn about scientific viewpoints from a broad range of perspectives. Diversity is a crucial piece of the mentoring jigsaw puzzle.

3. Mentoring in the Context of a Learning Community

The students in Purdue's Statistics Living Learning Community (STAT-LLC) share common experiences, which help them to build a sense of community. The STAT-LLC consists of 20 sophomore students. The students are not necessarily pursuing a major in statistics, but they have a strong interest in how statistics and data analysis will be used in their future careers.

Each student pursues a full year of research with a faculty mentor. Although their projects are all quite different, the students all commiserate with each other when their research is challenging or does not go as planned. They also help each other, especially when one student's skills can be used to aid a fellow student on her/his research project. The peer mentoring element is one of my favorite aspects of the STAT-LLC.

The students all take three courses together as a cohort: probability, statistical theory, and introduction to data analysis. By taking the courses as a cohort, the students naturally study together and help each other to reinforce the material. Learning as a community inevitably makes the academic experience more enjoyable.

The students have a year-long professional development seminar. They meet alumni, statisticians, data analysts, faculty, graduate students, and staff members, from all kinds of programs and professions. The seminar is dedicated to opening students' eyes

to the many ways that statistics can be used in the workforce. We also emphasize resources to better help prepare students for post-college opportunities, in graduate school and/or in many kinds of employment.

Very importantly, the students all live on the same floor of a residence hall. I am thoroughly convinced that most of the learning that happens in college is actually happening in the residence hall, not in the classroom or research groups. The residence hall is the place where the students spend time-solving problems in statistics, working on their mathematics, and honing their computational skills. As the students support each other in their learning efforts, I am increasingly convinced that their diversity of experiences and their sense of community are the key reasons that our students are so successful.

As a result of participating in the STAT-LLC, the students have an improved self-efficacy. They feel better prepared to succeed, because they help each other, and because they see that everyone occasionally struggles with coursework, research, and career choices.

My hope is that many statistics programs would begin to implement more community-oriented programs. I witness the beneficial impact of our living, learning community program on a daily basis. Indeed, I view the development of the STAT-LLC as the most important achievement of my career to date. I would be delighted to help any departments to develop similar efforts.

It is not necessary to implement everything; it is more important to find new, innovative structures that support a department's learning environment. Coordinating undergraduate student research (especially in the early college years); having cohorts of students who take courses in blocks; designing professional development seminars; and working with residential life colleagues on opportunities for students with common interests who live together ... These opportunities allow students to flourish in their undergraduate experiences. The benefits of such innovative programs are enormous. Individuals reach their maximum potential, and an entire department can be reenergized, as a result.

4. Advice to Student Mentees

4.1. Read Directions

It is important to read directions carefully. In college, my girlfriend (now wife) and I took a course together. During the final exam, she finished relatively quickly and left the exam room, but I took the entire class time and barely got through my exam. Exasperated, after the exam, I asked her how she managed to get through all 20 questions in such a short time. She gently pointed out that the directions said that we only had to solve 7 of the 20 questions. One might think that I learned my lesson after this, but several years later (in graduate school) I took an examination that had questions on both the front and back of the exam sheet, but I only saw the questions on the front of the sheet, and therefore, I failed the exam.

The need to read the directions has made a big impact on me. Now, when I apply for federal grants, I read and reread the entire solicitation many times, so that I can be sure to avoid making careless mistakes or omissions. My style, when working with students, is to tell them some humble stories, about embarrassing things that I did as a student, so that they can

learn from my mistakes. The best mentoring advice is sometimes like a strong medicine: To make it easier to swallow, it helps to have a dose of self-deprecating humor from the mentor.

4.2. Mathematics and Statistics Are Not Spectator Sports

Another piece of advice I give to students is to solve as many problems as possible when taking a course. My favorite mathematics books—the ones that are nearest and dearest to my heart—are the ones with the broken spines. They are heavily highlighted and underlined, with extensive notes in the margins. I like to read the material in a book chapter two times, and then to solve all (or at least the majority of) the exercises in the chapter. I have a pin in my office that says, “Mathematics is not a spectator sport.”

It is especially valuable to read and reread the classics in statistics and mathematics. Such books are one’s lifelong friends, and they can be revisited throughout one’s career. Building a relationship with such books is not a passive activity. It is necessary to solve the exercises and to become familiar with all of the nuances of the views from the experts. It takes a lifetime to master a really classic book in statistics. The history of statistics is rich with interesting stories, which can be helpful for students when they are making a transition into the discipline. All students would do well to read DasGupta (2011), and then to obtain copies of the classics mentioned therein, and finally work through such classics. Students are also strongly advised to spend time immersed in the journal *Statistical Science*.

4.3. Applying for Opportunities

A colleague told me that, just like with an exponential random variable, there is an exponential decrease in the reader’s attention when reading an application. All of us who have served on selection panels or admissions committees can relate to this, but this is something that students often do not realize. Many students write their personal statement in a chronological way: starting with K–12 experiences and working toward their current experiences. I encourage students to (instead) just write about where their career is headed in the next 5–10 years, at least to the best of their abilities. This is harder for many students to do, but it forces the students to focus their writing and to only include the most important and transformative aspects of their training and preparation. By putting the focus on future goals, the students always end up shaping their application in a more meaningful way.

To make an application be focused and detail oriented, I share some advice that I learned from a colleague about avoiding “cut and paste” sentences in one’s application. These are sentences that do not say anything specific about the candidate, for example, “I always loved statistics,” or “I like working with people.” Instead, I encourage students to focus on specific things that they have accomplished—the defining moments in their training and experiences—that insightfully demonstrate what the students want to convey. If a sentence is so generic that it can be “cut and pasted” into someone else’s document, then that sentence needs to be removed from the student’s application.

4.4. Time Management

I remind students that we all only have 24 hr in the day, and it is important to spend most of one’s time doing what one is most passionate about. Moreover, we are not as good at multitasking as we think we are. The desire of many students to be online all the time means that their time is more fragmented. I encourage them to turn their phone off while studying. I urge students to designate fixed times in blocks, in which they can focus on their studying without online distractions.

I also encourage students to leave themselves sufficient time to revise, revise, revise. This applies not only to writing and to proofs, but also to data analysis, programming, data visualization, etc. It is important to review our code and to revise our visualizations of data, just like we review our writing. As we spend more and more time rereading/revisiting our work, discussing our work with peers and mentors, and then refining/revising the work, our final product achieves a much higher quality.

Also, sleep is important, and eating is important. For students who allow their socializing or online time to overtake their study time, it is helpful to schedule their relaxing time (in advance), and then to set an alarm for when that time is over, and get back to work. Setting expectations for oneself ahead of time is an excellent time management strategy.

5. Computing Advice

Regarding computing—from a philosophical viewpoint—Jeanette Wing’s article on Computational Thinking (2006) does a great job of describing how people think about problems to be solved. She believes that computation is pervasive, and algorithmic thinking can essentially impact our whole approach to science. She mentions machine learning explicitly, but her vision of computational thinking seems extendable to the entire field of statistics. All types of statisticians need to be able to translate knowledge of statistics, mathematics, algorithms, and domain expertise, into computational methods. I highly encourage my colleagues and students to read her article.

Much of the data analysis in my courses involves introductory, fundamental aspects of using the computer as a tool. For this reason, I am often mentoring students about basic aspects of computing, and urging them to learn fundamental skills. As a simple example of this, I frequently urge students to learn about touch typing, as one of the few ways to buy oneself more time in every day. It is also worthwhile to learn an editor such as emacs or vi, and to become familiar with all of the shortcuts and time saving tools it provides. As my colleague Doug Crabill often points out, one’s computational environment is important but is a very personal choice.

Knowing UNIX tools for data wrangling has limitless advantages over less savvy tools such as spreadsheets. At Purdue, my students learn R, UNIX, bash shell, awk, SQL, and XML scraping and parsing when they are still sophomore undergraduates. We want students to become familiar with computational tools as early as possible in their training, so that they can hone their skills and reap the benefits of these tools throughout their careers. Whether or not the students become statisticians or data scientists, we know that students will be working with data in almost any career they choose.

I tell my students that they would not endeavor to build a house with only one tool, such as a hammer. Similarly, to be a statistician (or, more generally, any kind of scientist), there is a lot of value in being comfortable with many computational tools and algorithmic approaches to problem solving.

6. Measuring Success

To measure if a mentor's work has been successful, we can ask ourselves: Has the mentee developed as a scholar? Developed as a person? Has the mentee learned skills that will help her/him to persist with an enjoyable and fruitful life? How much time did we invest with our mentees? Is the mentee more comfortable, confident, knowledgeable, and experienced, as a result of the mentor/mentee relationship? Does the mentee trust the mentor and use the mentor as a resource and source of help?

In a very successful mentor/mentee relationship, the conversations will continue long after the undergraduate experience is over. Years and years later, the mentee can still reach out to the mentor. With help from the mentor, a mentee can cross bridges into wonderful, undiscovered territory. To help a student blossom, grow, and transition into a successful career is one of a mentor's most rewarding experiences.

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