Science is Hard [1]

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Science is exciting. Fact. We know this is true because, since science is also difficult, nobody would bother doing science if not for the excitement. They'd pick something that pays better and lets you leave right at 5 pm every day. You could not show me a scientist who is never stimulated while inventing a new theory, ecstatic when experimental evidence proves conclusive, motivated to solve one of society's great problems, or enthralled when learning about the mysteries of the universe.

Still, science is difficult. A scientist spends years of intense schooling to hone his or her mind for years of long, boring, and often thankless work. While I am no doubt enthralled by scientific progress – from rocket ships to cancer treatments – as much as the next person on the street, the only thing that will ever distinguish me from a mere fan of science is becoming comfortable with the "boring" parts of science. These are things that make true discovery possible and useful, though they distract the mind from the joys of discovery. These are things like working with people from different academic and cultural backgrounds, making it all the more difficult to stay on the same page during research. Like keeping a lab log book with madly precise details or handling experimental set-ups with painstaking care to keep from breaking or contaminating anything. Like wading through dense scientific literature to find a single useful idea, which might not even be there, and doing that for hours every day. Like learning to use dozens of laboratory instruments,

to stay in constant communication with many other people in the research group, and simply staying organized.

This summer, I am more or less on a 2-month crash course to get familiar with the less-than-glamorous grunt work of scientific discovery. I am an undergraduate; I have little prior research experience, that of which I do have doing running simulations in a small lab; I am a physics major. Yet, suddenly, I'm working full-time in the chemical engineering department at a massive public university, trying both to contribute something useful to science and to work between busy schedules and tight lab spaces.

The first lesson began even before I arrived. The REU program in which I am participating, run by the University of Puerto Rico in Mayagüez, ran into logistical problems due to uncontrollable political circumstances. As a result, my work was relocated to the University of Wisconsin-Madison. I was rather disappointed initially (as Wisconsin is a far fling from Puerto Rico), but I've come to appreciate the sudden change. As a scientist, my primary job is and will be to produce knowledge. For the field in which I'm researching (liquid crystal dynamics), location does not matter. Even though my specific investigation is different because I am in a different lab, as an undergraduate a slight change in topic will not put a kink in my career path. My goals are not to pursue a specific problem (not yet, at least), but rather to gain experience. This is a goal which can weather a simple change in location. Politics, economics, and even social circumstances can hinder and even stop a scientist's ability to investigate his or her chosen problems. In some fields, scientists may face challenges performing research wherever they go due to such barriers from the "real world" outside academia. For some, funding is not nearly as accessible, and for some (such as atmospheric and climate scientists), a sizeable portion of society may downright disregard the integrity of their field.

The learning curve only got steeper once I took to the lab, though. Keep in mind that I study physics; I have only taken two semesters of general chemistry, and that was two years ago. Suddenly, I was expected to be able to competently use vials, pipettes, hot plates – all the chemical laboratory trinkets. The first sample I measured was supposed to be 20 *micro*liters. I was almost finished setting the pipette for 20 *milli*liters before my lab partner caught me. How was I supposed to know that the number "20" I was reading on the side of the tool meant a volume 1000 times the size of what I needed?

As for all the equipment and softwares I have spent days learning to use, I will probably never use most of them again after this summer. Learning them isn't a waste of time, though. Mastering these dozens of tools drills my mind to develop the thought processes required to pick up new skills. Scientific pursuit is guided by the content of nature's mysteries, not by the type of tools you already know how to use. As such, learning how to learn things is much more important than learning what I think are the "right" things in one moment.

The most taxing aspect of science, though, is the information management. Log books should be kept in excruciating detail. Even though, in reality, few of those details will be useful, a trivial note on a sample preparation could be needed to explain a ground-breaking observation made accidentally three weeks later. Information needs to be shared with the other researchers, but I must carefully select what needs to be shared so that my lab's principal investigator is not bogged down by hours' worth of trivial details.

The funny thing is, though, that the experimental information I collect and manage cannot be separated from science itself, or from the thrill of scientific discovery. Neither can the laboratory equipment, nor the software, nor the conditions of the world outside the carefully controlled laboratory where the research must have some kind of relevance. These things are boring and difficult, but, after getting the hang of them, I've begun to see much better how they're related to the great scientific adventure. While before they seemed to just be things in the way, making the effort to climb over them has made it apparent that they are some of the most important pieces of the road. Science is difficult, but the very things that make it difficult are also key to making it exciting.
