Using Data First in Teaching about Global Change

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Asking students to create graphs first, before any analytical discussion on the trends or correlations

Using Earth Data in teaching a global change class is not new to faculty. Most of us take advantage of the rich ice core data from Vostok, data from Mauna Loa showing trends in carbon dioxide concentration, or decadal climate data from Niwot Long Term Ecological (LTER) Station. Students are usually spellbound by the graphical presentation of such data, but are generally oblivious to the analytical interpretation. While we clearly value higher order thinking by students, we often fail to expose students the painful process of analyzing, interpreting, and defending judgments. More often than not, this failure is driven by institutional control over our time with the students: The fifty-minute lecture "hour." A possible solution is to change how we utilize the time and the instructional structure.

Danny Edelson's *Learning for Use* (LFU) Framework provides us with a simple structure that allows us to present the students with the "unpolished" data *first*. Rather than present the students a artistic and data "clean" graph, typically embedded in a PowerPoint slide accompanied by a few important bulleted points, how about *forcing* the students to create the graphs *first*, before any analytical discussion on the trends or correlations? Constructivist teachers will argue this presents an opportunity for students to create "knowledge gaps," which in-turn, motivate (LFU step 1) learning (Edelson, 2001). What the faculty member discovers is that students who create their own graphs often misinterpret the data, presenting *teaching moments* to the instructor. Or, better yet, students generate their own interpretative discoveries about the data. Students are building new knowledge (LFU step 2). Continue the instructional process with opportunities for students to apply and refine their new knowledge via the introduction of new, similar datasets (LFU step 3).

During my the first day (fifty-minutes!) of a global class at the University of Northern Colorado, students were asked to access and download climate data from Niwot LTER Climate Station 3 for the period 1990-2001. Students were asked to make a simple time-series plot of maximum and minimum temperature. Once the graphs are created (and a few *teaching moments* about creating time-series plots), students are ready for a general class discuss on interpreting the graphs. The first class was dedicated to creating the graphs.

The second class was dedicated to discussion about the graphs the students created, including trend lines. I found that many of the students had consulted amongst each other in the interim, particular on the details of polishing their graphs. An interesting experience emerged from the discussion: Students failed to recognize an anomalous data point (See Figure 1). April at nearly 3500 meters in elevation, a maximum temperature of 78°C is not realistic. However, because students were able to create the graph, they failed to question the validity of the data point. This example presented *motivation* to learn new knowledge: What happened to cause the data to be erroneous?

This experience would have never happened if I had just presented the students a "polished" graph of the data, which does show a slight positive slope in both maximum and minimum temperature (*after* the erroneous data point is removed). Moreover, students were now motivated to examine other datasets from Niwot (and other climate stations around the world, particularly in the southern hemisphere). The third class meeting was dedicated to presentation from students who did, indeed, examine data from other climate stations. Driving question: Collectively, do all the other high altitude climate station data show the same slight positive slope in maximum and/or minimum temperatures?

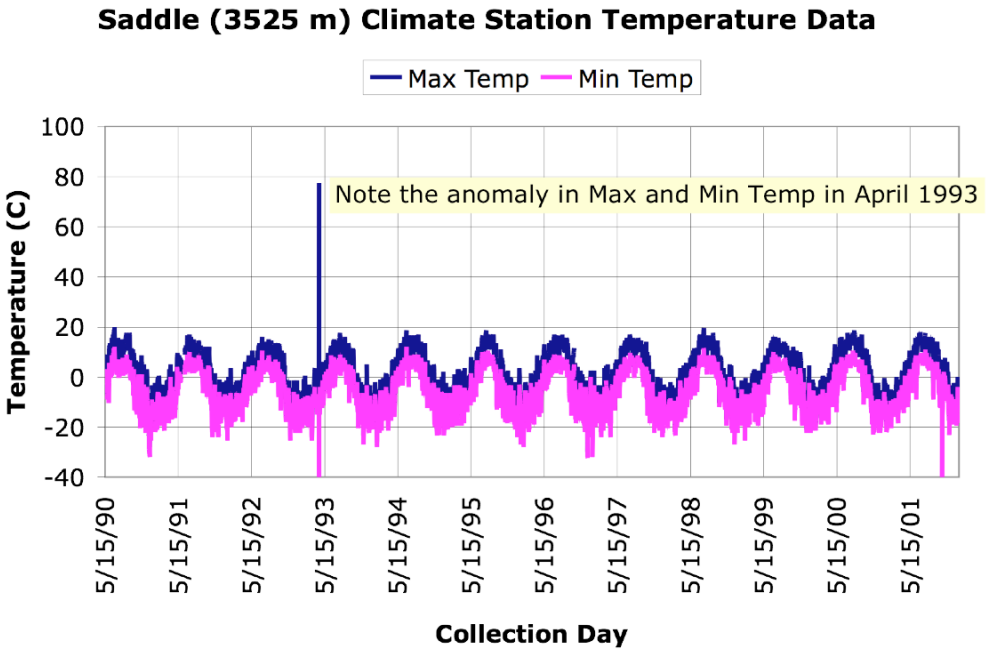

Figure 1. Plot of maximum and minimum temperature for Niwot Saddle Climate Station. Data is from May 15, 1990 to January 13, 2002. Cause for the anomaly on April 16, 2003 of 77.5°C (maximum temperature) and -50°C (minimum temperature) is speculated to be an erroneous voltage reading by the data logger.

In three class periods, students had clearly conducted more critical thinking than ever before in my class. I sacrificed my "polished" slides *and* my laundry list of "must cover" topics for a new instructional structure: Monday's goal - get intimate with the data (on whatever topic we need to understand); Wednesday's goal - discuss, refine, and question; Friday's goal - apply what we learned so we can begin to understand.

Edelson, D.C., 2001. Learning-for-use: A framework for the design of technology-supported inquiry activities. Journal of Research in Science Teaching. V. 38, no. 3, p. 355-385.