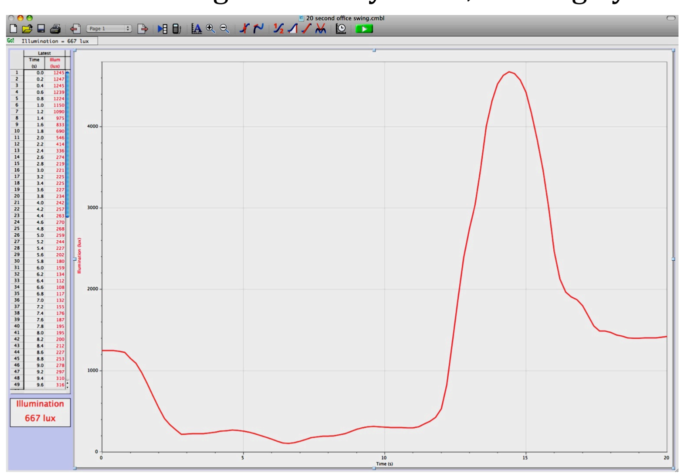
Northwest Math Sightings – Seeing the Light – and Counting It!

Students in our math classes legitimately ask us sometimes, "When will I ever need to know this stuff?" It's a question that has many answers depending on who has asked the question and why. Over the years good teachers develop a skill at fishing out the response that will work for this or that student at this or that moment. Sometimes it concerns an application in "real life," sometimes it has to do with requirements for the next course down the curricular line, or for tests the student must pass and so forth. My favorite answer, though, is this: "When you understand this math your life will be more interesting. Let me explain…"

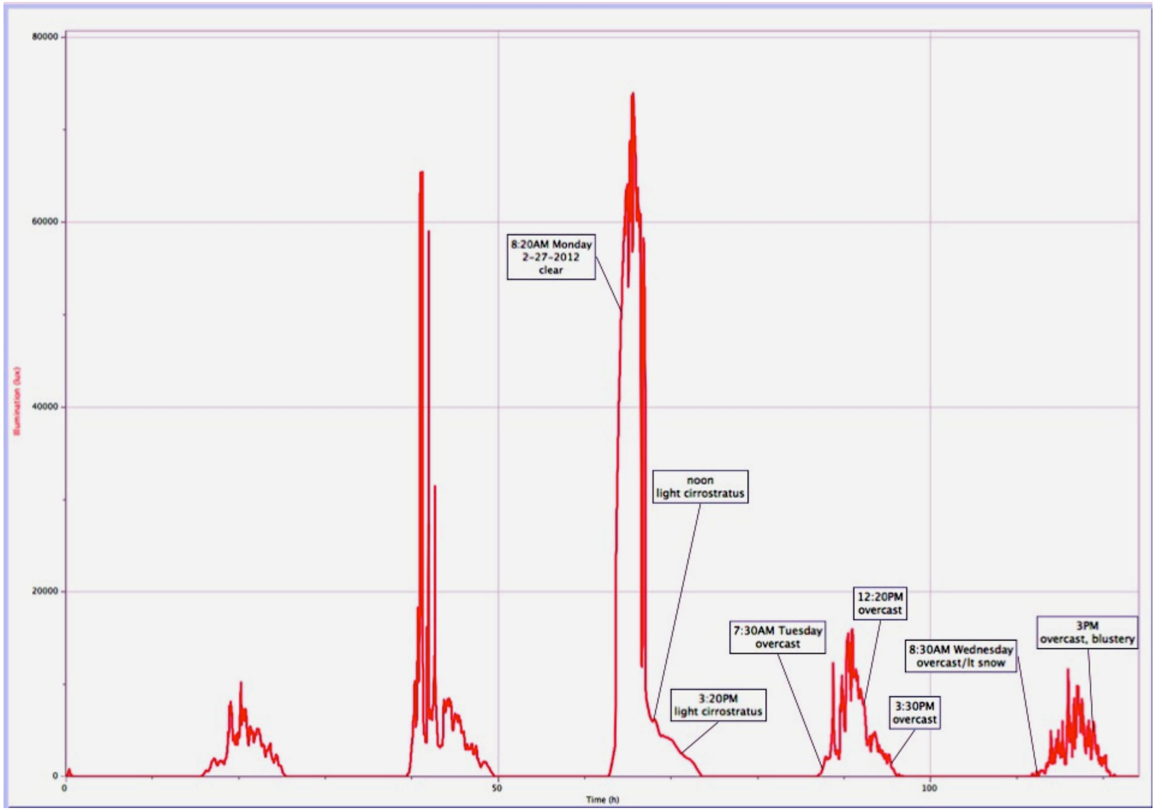
The Light Probe It was Friday afternoon, around 4PM toward the end of February - the 24th, to be exact. I looked out my window. It wasn't yet dark but it was a little dreary. I was cleaning up a few things, getting ready to go home and I came across a glass tube with a wire extending out one end and a shielded sensor staring out the other. I followed the wire through a couple of junctions to a USB plug. It was a light sensor, one of several data probes I got a few years back. While I have used the temperature and sound probes a good deal the light sensor has been less useful. It seems I don't really have a need to quantify light; it's just there or it's not, in which case I flip a switch. Nevertheless I plugged in the probe, fired up the data logger software and recorded a 20 second swing around my office, starting by pointing toward the book cases on the south wall and gradually rotating 360° so that I ended facing the south wall again. Figure 1 shows the record produced by the software. The x-axis is time (20 seconds) and the y-axis is lux (think of it as light intensity). Can you guess which wall is mostly window?



S W N E S

Figure 1 - Twenty second swing around my office.

Before I left that afternoon I set the probe up, aimed out the window at a point low on the southeastern horizon. I set the software to record ten times per minute for 124 hours (five days and 4 hours), turned off the lights and left. Returning Monday morning I found an interesting record of the weekend. Saturday had been overcast but Sunday had seen a few brief sunbreaks in the morning before the clouds rolled back around noon. The next few days brought several sorts of weather including wind, sun, periods of overcast and even some light snow on Wednesday morning. Figure 2 is the record of those 5 days. As in Figure 1, time is on the x-axis and light intensity (lux) is on the y-axis.



Saturday Sunday Monday Tuesday Wednesday

Figure 2 – Time (124 hours) vs. lux (0 – 80,000). 2012-02-25 through 2012-02-229

Light Comes and Goes A closer look at the graph, the units and the scale make me wonder about the probe's sensitivity to direct sunlight as well as the range settings, which I chose somewhat haphazardly on that Friday afternoon, and the subsequent accuracy of the measurements. Nevertheless, there is a remarkable difference in the records of Sunday and Monday (the second and third days on the record) versus Saturday (the first day), and the last couple of days, Tuesday and Wednesday. While Monday morning had been clear and sunny, by noon we had a layer of cirrostratus, often a forerunner to an approaching weather system, and the next two days were overcast and windy with rain and even a little snow Wednesday morning.

Thinking about the graph, it seems clear that the area between the curve above and the x-axis below tells us something about how much sunlight we received each day. Those with a little calculus under their belts will recall that you can use integrals to find that area. The software comes with an "integral" tool that allows me to select a range on the x-axis and estimate an integral over that period. Doing so allows me to compare in a rough way, the amount of sunlight received. Table I shows the results of these calculations for each of the five days.

Saturday	Sunday	Monday	Tuesday	Wednesday
30,200 h*lux	61,900 h*lux	211,000 h*lux	45,100 h*lux	27,900 h*lux

Table 1 - Light under the curves for the 5 days

I can see that according to these measurements we went from a high of over 210,000 units of light on Monday to a low of only about 28,000 units on Wednesday, the last day of the record and one with an overcast thick enough to produce snow and rain. The record of just these few days encourages me to infer that a solid and persistent layer of clouds can reduce by a factor of at least seven the amount of sunlight we receive on any given day. The simple math serves to underscore the fact that though we complain to our friends who live in sunnier climes, we don't actually live under a sodden blanket of drizzling grey clouds that stretches from October through late June. There is variation, even on the west side of the state.

The extraordinarily useful Web site, *Gray Skies*, created by and hosted at the University of Washington's Atmospheric Science department allows me to investigate extensive records of a number of intuitive and interesting weather variables. While "lux" is not one of them, the closely related Solar Radiation,

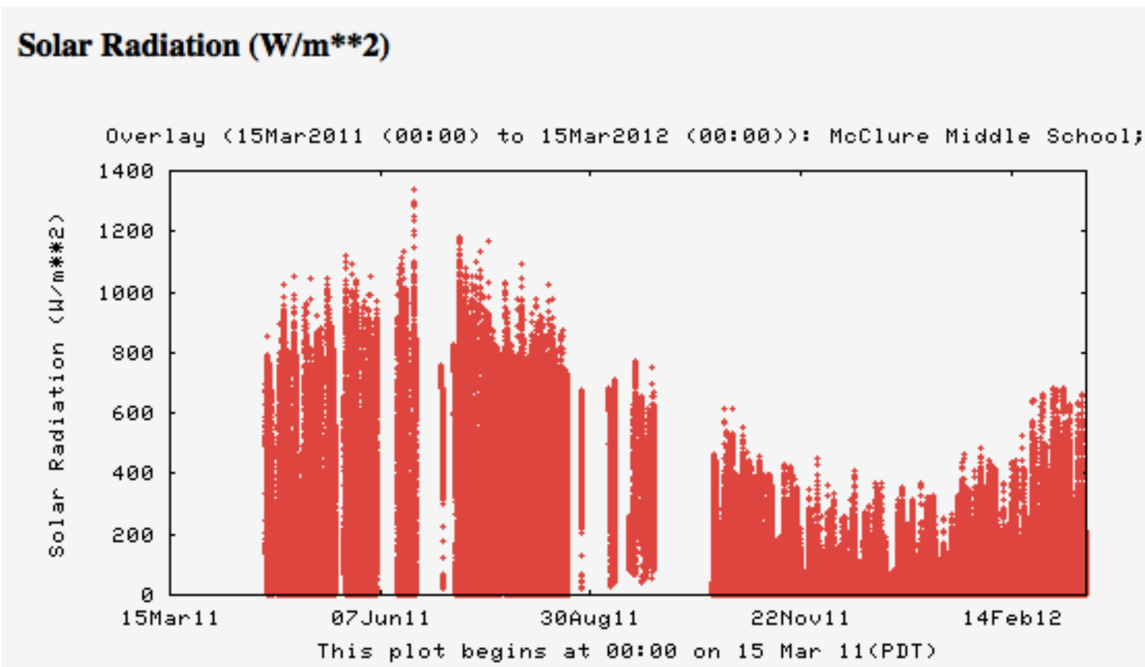


Figure 3 - One year of solar radiation data from McClure M.S. in Seattle

measured in Watts per square meter is available at a few stations including McClure Middle School in Seattle. Figure 3 shows a year's worth of these data, from 15 March of last year to the same date this year. (The blank regions represent missing data.) From this graph it is clear that the amount of sunlight received by these middle schoolers shows a strong trend over the course of a year. The shape of the curve reminds me of a sine (or cosine) function and I wonder if I could get students who are learning about basic trigonometry to model the seasonal coming and going of the light with one or another of these functions.

Of course sunlight or its absence here in the Northwest is just one variable that we encounter on a daily basis and mostly take for granted. Some others include temperature, wind, and rain. Figure 4 shows the record of cumulative rain amounts over one year from January, 2011 to the end of that year.

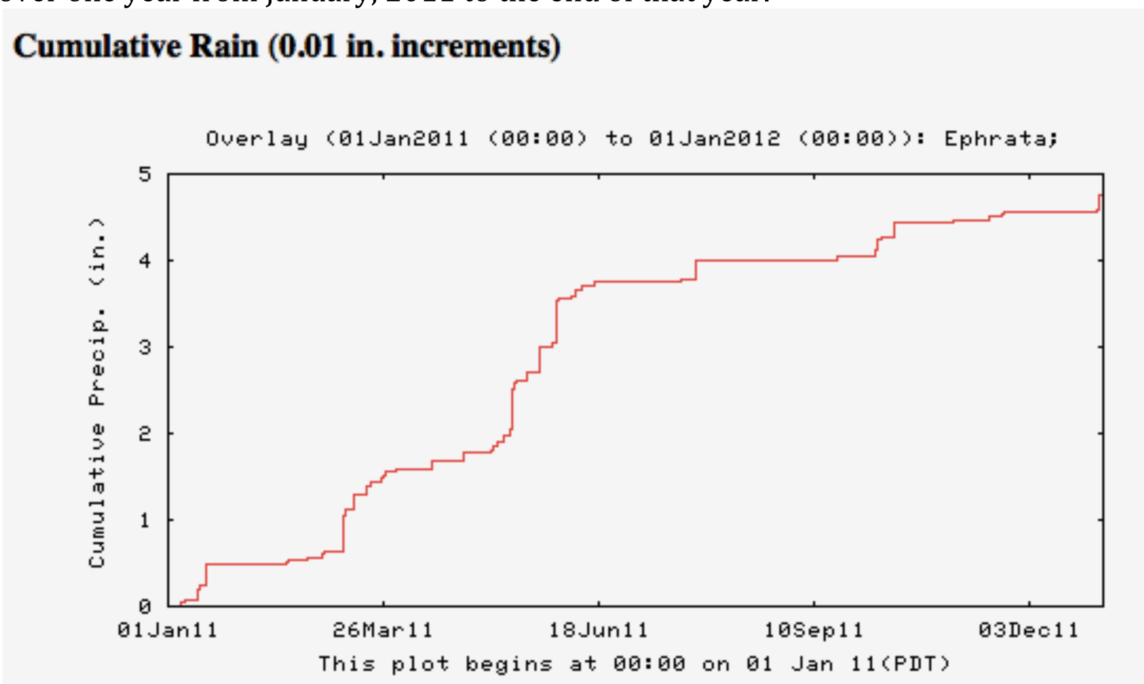


Figure 4 - Cumulative rain 2011 - Ephrata, WA

What does it mean when the graph is flat? How about those sudden steep rises? Why does the graph never fall as we look from left to right? These are questions that might prompt a 6th grader just developing her understanding of slope to make connections between real life and mathematical representations of our daily experiences.

Conclusion For too many of our students, particularly those in the upper grades, mathematics is just a subject to be endured, or worse, avoided. What if instead it could be a stimulus to pay attention to the world all around us, to pose questions and seek answers? If we can help our students see math as a way of making sense of the world, we have done them a service that can last a lifetime.

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Note: A new (still in beta testing) Web site, WeatherSpark serves weather data on a grand scale. Search for any city on earth and access historical, current and forecast data for a wide range of weather-related variables.

References

Gray Skies: http://www-k12.atmos.washington.edu/k12/grayskies/nw_weather.html
Weather Spark: http://weatherspark.com/