Free Experimental Design

Just to see what level students are able to handle independent of any ‘standards’ or so

Ages : 6-12

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Two sequences of a series of lessons to see how far we could get reading weather maps; a description by the designer/teacher

Oxford, 2013

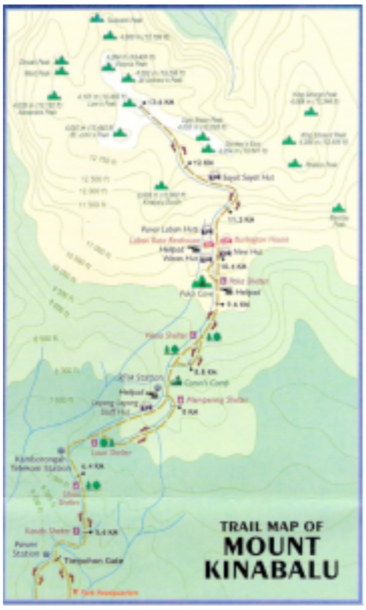
Rain or shine

Curious about the next topic, the students in the lower grades gradually enter. The topic's already on the screen: RAIN or SHINE. That looks interesting. But they're put on the wrong track immediately: we're fist going to discuss HIGH or LOW, especially in relation to mountains and valleys in nature. As an introduction a short video of Mount Kinabalu, a magnificent mountain in Sabah, Malaysia, is shown. Sabah isn't very well known to many adults (it's a part of Kalimantan, formerly Borneo), and certainly not to young children. That only makes it more exciting.

http://www.youtube.com/watch?v=pWTq4WBh264&feature=fvsr

Mount Kinabalu is popular and beautiful for various reasons: if you climb it you will see just about all climate zones: at the foot of the mountain tropical rainforest, at the top bare rock, with two peaks over 4000 meters. Another reason is the relatively simple ascent. Finally, the spectacular view from the top at sunset: you have the Philippines at your feet.

It makes sense to first look at a map with the route. So that is what we do in the group:

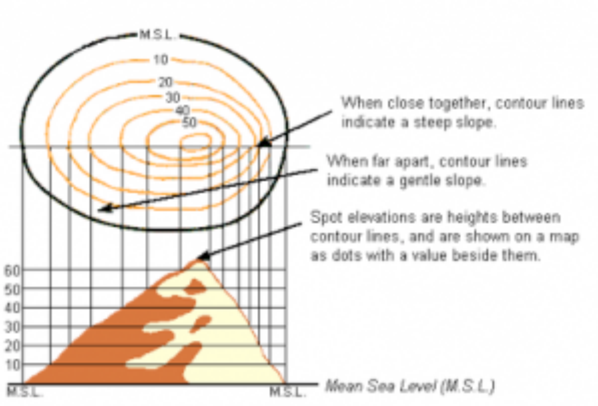


http://mappery.com/map-of/Mt-Kinabalu-Trail-map

A map like that is a good talking point, especially when they spot the numbers 10 000, 10 500, 11 000 etcetera. “You can see you’re going up”, someone says fairly soon. Of course, you need to mention that this is the height in feet. May as well use the memory aid: feet times three gives meters and the other way around. The two peaks are spotted quickly: the highest, Low’s Peak, is 13 455 feet high. Check the memory aid; the map says that 13 455 feet equals 4101 meters. 13 455 : 3 = 4485 meters. Significantly more, but close enough in order of magnitude.

The younger children (from 6 years old) also quickly see the relation between contour lines that are close together and the steepness of the ascent. No big deal. Big numbers, linked to the mathematical concept of slope or steepness? No problem.

Next we look at a few nice pictures in the PowerPoint. They show the relation between the three-dimensional world and how that same world can be brought to life with contour lines. One of the pictures shows a mountain in side and top view:



http://www.nrcan.gc.ca/earth-sciences/geography-boundary/mapping/topographic-mapping/10131

It’s really remarkable that the younger children are also able to handle all these concepts in this almost tangible context. That’s going to make things exciting when we move on to high and low pressure areas, since those are a lot less tangible, even if their consequences can be felt physically.

After extensive discussions about contour lines, slopes, steep and less steep routes on maps, based on the contour lines, it’s time for a challenge. They get a map with height values, and are asked if they can draw in the contour lines. Seems simple, and yet:

Hieronder zie je de hoogtes van een bepaald gebied. Teken de hoogtelijnen door de punten met gelijke hoogten te verbinden. Kunnen hoogtelijnen elkaar snijden?

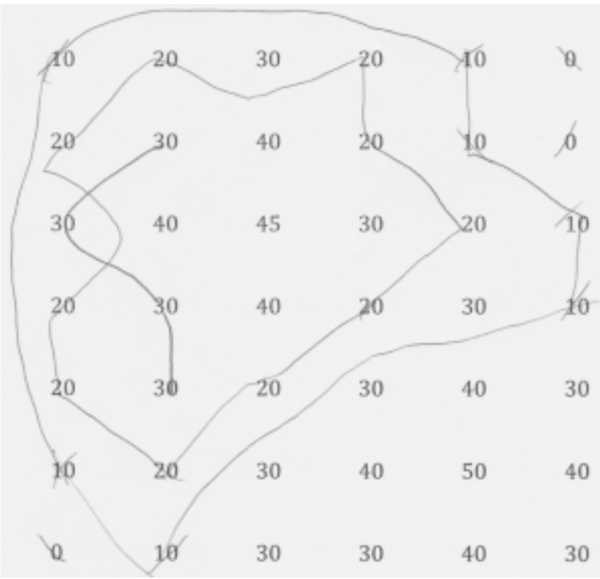
10	20	30	20	10	0
20	30	40	20	10	0
30	40	45	30	20	10
20	30	40	20	30	10
20	30	20	30	40	30
10	20	30	40	50	40
0	10	30	30	40	30

Waar zijn de toppen?

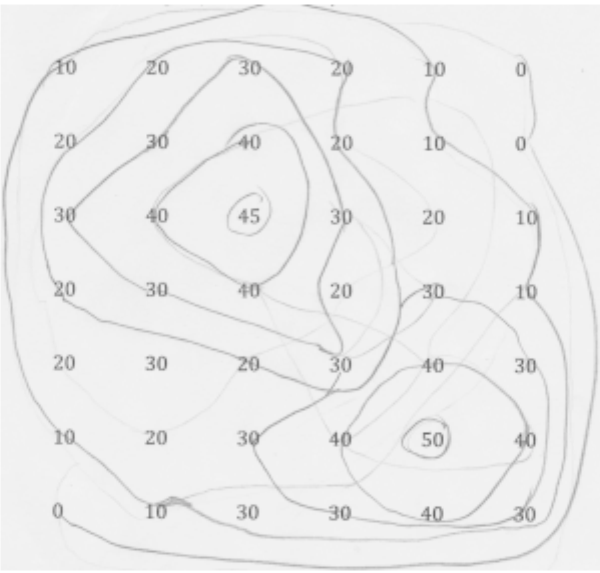
[below, you can see the heights in an area. Draw the contour lines by connecting points that are the same height. Can contour lines intersect each other?]

[Where are the tops?]

The students go to work with a combination of great enthusiasm and a certain degree of underestimation, and produce for instance this chart:



A number of students quickly see that contour lines can't intersect: "because then you have a point with two heights." That's impossible. Although the following 'solution' isn't perfect either, the overview comes fairly close to what it should be:

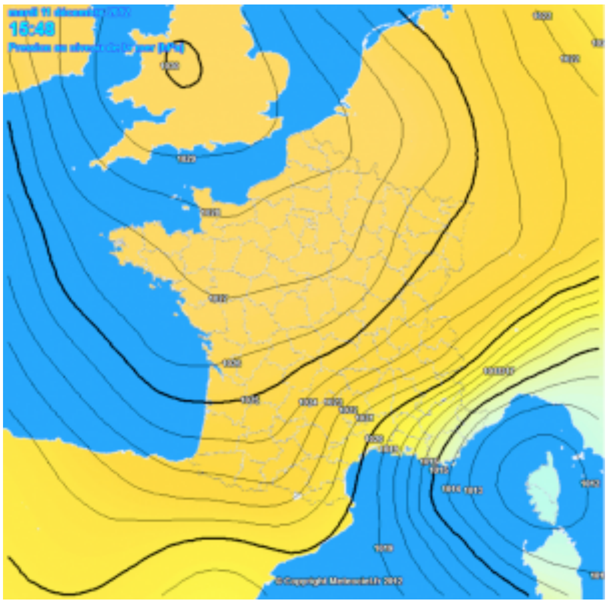


Again, a fantastic lesson. It would go too far to say that we introduced functions with two variables. but that the children have been working so well with mathematics, even if it's only at the gates, is a welcome bonus. A height is added to every point in the plane (with coordinates), and we will further extrapolate on that in a more abstract context: the weather. More about that the next time.

Coriolis syrup

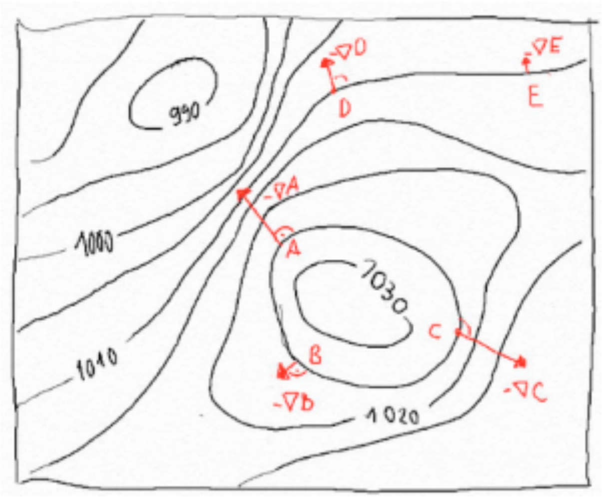
Following up on the good experiences with contour maps, the next step should be that towards the much more abstract weather chart. Let's start with a brief look back to see how much the students had retained from the contour maps. Well, pretty good. Really good in fact. So, swiftly on to weather charts. Starting with yesterday's chart (December 11, 2012), courtesy of Ruben Weytens' excellent website (http://www.rubenweytjens.be/waarnemingen.html).

This is what it looks like:



Of course, now yesterday’s weather is the topic under discussion: yeah, there wasn’t that much wind, that looks about right. A lot of explanation wasn’t needed: you can see it straightaway: the contour lines aren’t very close over the Netherlands. For strong wind you should look ‘there’: the weatherman of the day, quite correctly, pointed out the Riviera. That’s a stiff breeze. After looking at another weather chart the contour lines are named: isobars.

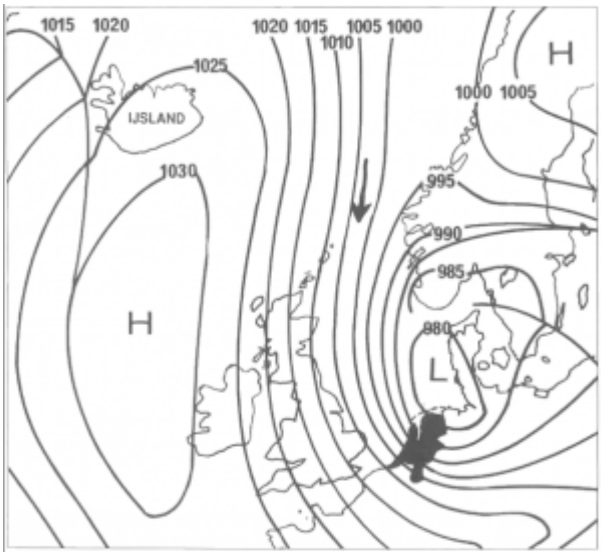
We slowly move on to the next underlying concept: how does the wind move from high to low? First a sketch from a French meteorologist:



A female peer from the group explains what we are looking at. A map with isobars. And arrows that go from high to low; perpendicular to the isobars. It’s logical, that’s how a marble would roll down. But there’s something special about the arrows: the closer the isobars are together, the longer the arrow. ‘Quite a few’ of the students noticed that quickly. That’s especially the result of the short arrows at points B and E: the contour lines are very far apart there.

Well: the arrows do in fact indicate the gradient: the slope in that spot. The children don’t lose interest for a moment. The authentic character of the sketch seems to work out well. Are they ready for the great confusion?

At the end of the previous lesson we had watched a video on the disastrous flood of February 1, 1953. Now we look at the weather chart for that day:



You can so to speak ‘see’ the storm before your eyes: the isobars are terribly close together over the Northsea. How is that possible?

I’d put in hours of experimenting. At home, with a nice big globe. The idea: perhaps, if I poured a slightly thicker liquid down from the pole, while the globe rotated in the right direction…. Interesting idea. Lemonade was too watery. Olive oil wasn’t a success either. Ah! bicycle-chain lubricant? A bit better, but not there yet. I scrutinized the content of my kitchen cupboards again. Pancake syrup? Yes! I’ll say in advance that it can work, but everything has to cooperate. It worked great in one group, in the other it was a bit stickier. But convincing: yes:

The syrup – excuse me, the wind – deviates strongly to the right, so much so that the wind runs almost parallel to the isobars.

The wind turns away to the right from the high pressure are and then turns in towards the low pressure in the same way. And that is caused by the Coriolis force, as the result of the rotation of the Earth. The syrup was the proof.