Mathematics and water in the garden:

Weaving mathematics into the students' lived environment

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highlights the mathematics involved in gardening in the context of limited water supply.

In an earlier issue of APMC, Sparrow (2008) discussed the concept of real-world mathematics and the use of mathematics to explore problems in real-life situations. Environmental issues have provided a context that some teachers have used for teaching mathematics (e.g., Campbell, 2003). An example of a particular environmental issue faced by many communities in south-eastern Australia is the drought that has lasted for some ten years now.

This drought has forced people to think more carefully about how to garden in a sustainable manner, including in the school garden. Evidence of this was seen in some schools that took part in the Australian School Innovation in Science Technology and Mathematics projects funded by the Federal Government from 2005 to 2008. I was a "critical friend" for some of these projects, and heard accounts from teachers that through some gardening activities, students experienced mathematics as a tool for solving real problems in their environment. This was seen as far more meaningful than solving endless textbook examples that rarely connected with students' own lives. Issues that students thought through related to how much water was needed for individual plants to grow, how water could be distributed to the school vegetable patch, and worms. Figure 1 shows a group of students planting out vegetable seedlings in a school garden.

Figure 1. Students planting out vegetables.

How much water?

The first issue to be dealt with was relatively straight forward. In one school, students in Grades 2 and 3 set up experiments in which they selected seeds, sowed them in various old plastic containers, and administered, in a controlled manner, different quantities of water. They found that if you over-water or under-water the seeds, they will not grow. Somewhere in between, however, the seeds do germinate. Growth is dependent on many things, but certainly there is a fairly specific "range" of the amount of water that optimises seed growth. The students were able to make charts and tables, and to draw some basic graphs to highlight their important results. One of the interesting things about this situation is that, unlike traditional classroom mathematical problems, this does not happen in two or three minutes: instead, the problem takes weeks to solve.

Watering the plants

A more complex issue concerned how to distribute water to the plants in a garden? After setting up a series of old ice cream containers or buckets under drinking taps to collect any spillage (see Figure 2), and at set times in the day emptying the collected water into a larger container, the older primary students in a second school had to solve the problem of how to get the water from the retaining tank to the garden plots. One solution was for students to haul the container directly to the garden, as shown in Figure 3, and siphon the water out.

Figure 2. Collecting water from dripping taps.

Figure 3. Hauling water to the vegetable plot.

Another solution involved hoses and drippers. One of the parents helped out by setting up a small pressure pump that allowed the water to be distributed under some pressure, rather than relying solely on gravity drip feed. The students also had access to piping that had water drippers at about every 50 cm. The question, as the students soon realised, became a spatial problem: how do you use the piping to cover the garden bed so the water is distributed appropriately to the vegetable plants? Figure 4 shows some of the designs they started to develop. Issues such as the angles of the connectors (only right or straight angles), and how much "bendability" (or the tightness of the curve that the piping could endure without deforming) were other practical, but also mathematical, issues with which students had to deal.

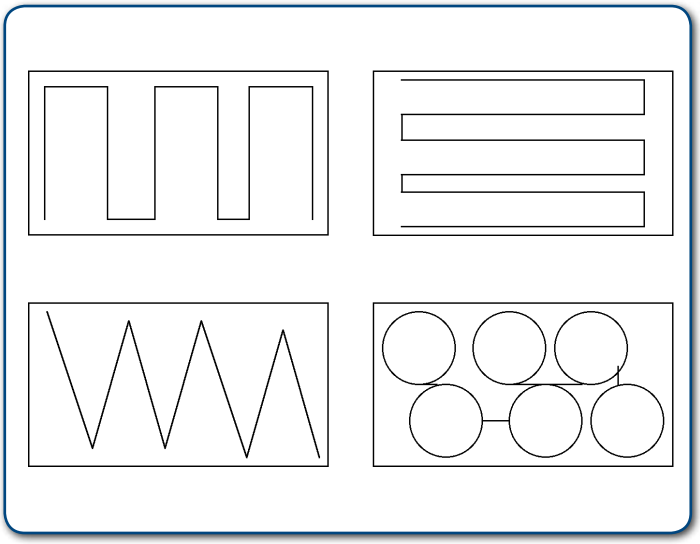

Figure 4. Students' preliminary designs on water distribution possibilities.

One possible extension of this activity could be to reconsider the original designs, perhaps when a new planting of vegetables was to take place. If they monitored the drip system closely, students might realise that using lines in their designs to represent the piping was not sufficient. Using lines does not account for the critical issue of how far from the piping the water will flow. Hence rather than a line, it might be better to use an envelope centred on the line to give a more realistic image of where the water will go. This has implications for their designs. This notion of creating and subsequently modifying, as more information becomes available, is an important mathematical process.

Fertilising

Yet another group of Year 5/6 students in a third school set up their own worm farm as shown in Figure 5.

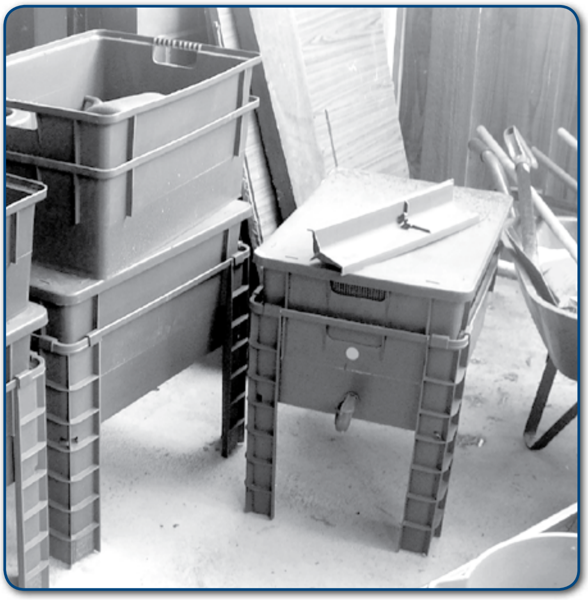

Figure 5. The worm farm containers.

There was a certain amount of recording of how long it took for the worms to produce suitable amounts of castings that were used on their vegetable plot. This was plotted and graphed, over a period of time. Again, the problem was not solved in five minutes or indeed one lesson, but extended over days and weeks. Some of the most useful mathematics came from the excess fluid that is produced from a worm farm and has to be drained from time to time. This "worm juice" cannot be used directly as a fertiliser but must first be diluted. The question then becomes what is a reasonable dilution factor to use. After using full strength "juice" and finding that was too strong for seedlings, the students found from the Web that about "1 to 9" or 10% strength was best—a figure generally accepted by gardeners. At the heart of this calculation is the notion of ratio, a key concept in mathematics, often used in science, but in fact a very difficult concept (Dole, 2008). This situation gave students a very practical context with which they were engaged and physical quantities to handle. This made thinking through of the mathematics much clearer. However, it was still important for the teacher to build on this situational mathematics to lead her students to the abstract place where they could also see the generalisability of what they had found when working with worm juice.

Summary

Many students have difficulty accessing mathematical ideas. This is understandable since many of the deep mathematical ideas are complex, and are not obvious parts of students' everyday lives. Students can, however, start to gain some deeper understanding of the nature of mathematics if they are faced with problems that are directly accessible and also part of their everyday lives. At present in south-east Australia, even young students are faced with the issue of restrictions on water use, and indeed other issues of sustainable living. Some schools have started with such problems, and let the mathematics unfold.

References

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