

Finding engaging ways of showing the use and purpose of compasses can be tricky. Colin Foster points us in the right direction

AMONG THE more pointless of textbook exercises, the following is a particularly spectacular example. "Use your protractor to make a 40° angle. Now, using compasses and straight edge only, bisect this angle."

Pupil: "Why not just draw a 20° angle?" Me: "Well exactly!" The problem with these textbooks is that the pupils who use them are more intelligent than the people who write them.

The task of making accurate constructions using just compasses and straight edge has more than historical interest. It does present an interesting challenge and a much-needed opportunity for some kinesthetic learning in the mathematics classroom, but presented simply as a way of accurately drawing angles, a protractor is likely to be seen by pupils as far superior to compasses.

To motivate the use of compasses, pupils need to meet tasks where compasses actually allow you to do something that would be much harder, more time-consuming, or less accurate without them. The mathematics behind compass and straight edge constructions is interesting and important – and a useful way of getting acquainted with the properties of a rhombus, so I feel that such topics are a valid part of the curriculum, but I have struggled for some time to find meaningful ways of introducing them. I have recently tried a scenario that I offer in the spirit of an invented puzzle, rather than a realistic context. I asked my year 7 class to use their imaginations on the following story.

Imagine you are travelling on a ship, miles from anywhere, when a storm breaks out. The ship begins



Pointless compasses?

to sink, but you manage to make it to an uninhabited island. After a while you realise you are never going to be rescued, so you begin to start building a civilisation. There are plenty of trees and sharp stones so you have wood and can cut it up. You begin to construct buildings, but there's a problem. The buildings keep falling down, because you do not have any right-angles. Right-angles are very important if you want to build buildings that go up vertically and have stable corners. So the challenge is to create a right-angle from what you have got.

My pupils immediately appreciated the idealised nature of the account – this was a "puzzle" to think about for the fun of it, not a real-life practical problem. There was a lot of excitement generated by the difficulty of making something that sounded so simple. Pupils discussed in pairs or threes how they might do it and then we shared ideas.

Some ideas that did not seem to lead to a solution:

- Make a circle in the sand and cut it into four quadrants – but how would you get the four quadrants exact?
- Use the angle between a plumb line and the ground – but is the ground exactly horizontal? (Incidentally, one pupil believed the piece of equipment in question was a "plum line" and you were supposed to use a plum for the weight, which hopefully you would find growing on the island, but if plums were not available others felt that any round fruit would do!)
- Hold out your hand and use the angle between your thumb and first finger – but how accurate is that, really?
- A strong sense that you could do something with a straight stick and shadows from the sun, but exactly what was never clearly articulated

One idea that I had not expected was the following:

Pupil: "Take a big leaf and fold it in half and then in half again – there's your right-angle!"

Me: "Yes, but the leaf you start with won't have right-angled corners."

Pupil: "It doesn't matter."

Me: "Doesn't it?"

The pupil then showed us with a piece of paper (I carefully tore off the right-angled corners first – he smiled, knowing it wasn't going to make any difference). The first fold makes a straight edge, and then if you fold against that you do indeed get your right-angles. This seemed obvious once shown, but it was a new thought for me – and clearly for the majority of the class, who gave a spontaneous round of applause.

The sort of process I had had in mind did emerge. You make some string (twisting grass together or something) and tie it to some wood and stick it in the ground. This makes your compasses. You can also get a straight line by pulling a piece of string taut, analogous to an ungraduated ruler (straight edge). So pupils set about finding how to make a right angle with their compasses and straight edge.

A follow-on task from this, suggested by the pupils, was to work out how to make a protractor (since the pupils had developed such high praise for that particular instrument!). How did people make the first protractor – did it come down from space? This led to another way of finding a right angle: you make your circle, lie string all the way round the circumference and then unwrap the string and fold it in half and in half again to get quarters of the circumference. You then mark it in some way and wrap it back around the circle to get 90°, 180° and 270°.

In principle you can divide up any angle into any number of portions using this method (by deftly folding the string back on itself however many times you need, like the way you fold an A4 letter into three equal pieces to get it into a long envelope), and so make your protractor.

For me, the positive side of this lesson was the creative ideas of the pupils, and the fact that far more thinking was going on than has been the case in the past when I have taught compass constructions in a "watch me; now do this" kind of way. I have never found that style of teaching very effective – many pupils seem to forget the procedures very quickly – and I hope that this more engaging approach will have more long-term benefit. See Ed

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