Mathematical Travels With Shockwheat

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1. Background

Around the turn of the millennium the Mathematics Department I worked in decided to use the Cognitive Acceleration through Mathematics Education (CAME) scheme with our Key Stage 3 students. We were given shiny new folders packed with resources, training sessions on how to deliver the lessons and a detailed timetable of the CAME lessons we were going to be teaching. It was exciting stuff.

I was an enthusiastic participant. The potential of the CAME programme was enormous– the main driving force behind CAME seemed to be a recognition that if we could embed mathematical understanding within our teaching at Key Stage 3 we would no longer have to go through the 'sticking plaster' approach that we have been employing for so long now as we desperately try to prepare our older students for their GCSEs – students for whom, in many cases, understanding of many key, and often quite basic, mathematical concepts has proven elusive.

So I prepared furiously for my CAME lessons, reading through the detailed lesson plans that were broken down into timed teaching episodes. Multiple resources were provided for each lesson, key questions were suggested in the lesson plans, even conversations that had been observed in trial lessons between students and their teachers. Every effort had been made to provide the teacher with all the information needed to ensure that the key ideas and aims of the scheme were delivered to the students. But when I came to teach a lesson I was hopeless! I can still remember the feeling I got as my mind tried to reconcile the tension between my natural instinct to follow points of departure that were occurring naturally before my eyes and the need to stick to the plan, lest some subtlety or other of the lesson was missed. I could only half recall the lesson plan, I had to keep referring to the notes; my lessons lacked spontaneity, inspiration and, ultimately, were not very enjoyable or fruitful for either of the parties involved. Teaching those lessons felt similar to the feeling of trying to re-type something you have already written but has failed to save – you know there were some gems in there, but you're blown if you can remember what they were. So you try to recall them, but only half manage it and end up with the worst of both worlds.

My experiences with CAME lessons were not entirely in vain, however, because, through my struggles, I learned that I am far more successful as a teacher when I have ownership of an idea – I know what my intentions are and I feel confident to explore tangents, wander down what may possibly be mathematical cul-de-sacs and, crucially, let the students dictate (to some extent) where we take the learning. Cribbing from a pre-determined lesson plan just does not work for me. As far as I am concerned, less is more – the germ of an idea is great, page after page of detailed notes is worse than useless.

The Core Maths Support Programme team have put much thought into the best way to provide information for teachers. We hope that by telling the story of the lesson, the route we took through using the resource will come across naturally, providing interesting, rich and relevant points of

departure with additional details should the teacher desire it. Ownership of the idea is ours; ownership of the development of the idea can be yours!

2. Shockwheat

Derek Robinson, Head of Mathematics at Bishop Luffa School in Chichester, has worked tirelessly to provide many resources for Core Maths and these can be found on the NCETM website at:

https://www.ncetm.org.uk/resources/45397

I have used the Shockwheat activity with my core maths class and have found it to be an excellent point of departure. Using it, I have managed to cover the majority of the data handling content from the core maths syllabus we are following in my college. At no point in proceedings have I felt tied to a script or even a scheme – the work has flowed from one idea to another, rather like the domino effect – and, therefore, the relevance of the mathematics being used has, hopefully, always been obvious to the students.

Shockwheat is, ostensibly, a vehicle for mathematical simulation. The task revolves around a set of memos sent by the management team of a failing breakfast cereal manufacturer.

Collect the set	
1. Mork the Dork 	2. Maudlin the Miserable 
3. Grusome 	4. Grunter 
5. Argumentative 	6. Never Satisfied 

Their idea is to include six different monsters to collect within their boxes – one per box. The task is to determine how many boxes need to be selected (on average) before a full set of monsters is obtained.

Like most great points of departure, Shockwheat is wonderfully simple. A six year old could have a guess at an answer and understand the concept yet, six weeks on from beginning to work on it my core maths class are still exploring aspects of the mathematics we generated from the initial data.

As my class is only small (five students), I felt it was sensible to 'borrow' some more students from a neighbouring class to help us collect the initial data. We ran the simulation with help from a year 10 class, each student pulling cards out of a hat until they had achieved a full set.

	Trial	1	2	3	4	5	6	7
	Random	6	4	4	2	3	4	4
Won on trial…								
8	Prize A	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
4	Prize B	FALSE	FALSE	FALSE	4	FALSE	FALSE	FALSE
5	Prize C	FALSE	FALSE	FALSE	FALSE	5	FALSE	FALSE
2	Prize D	FALSE	2	3	FALSE	FALSE	6	7
17	Prize E	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
1	Prize F	1	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

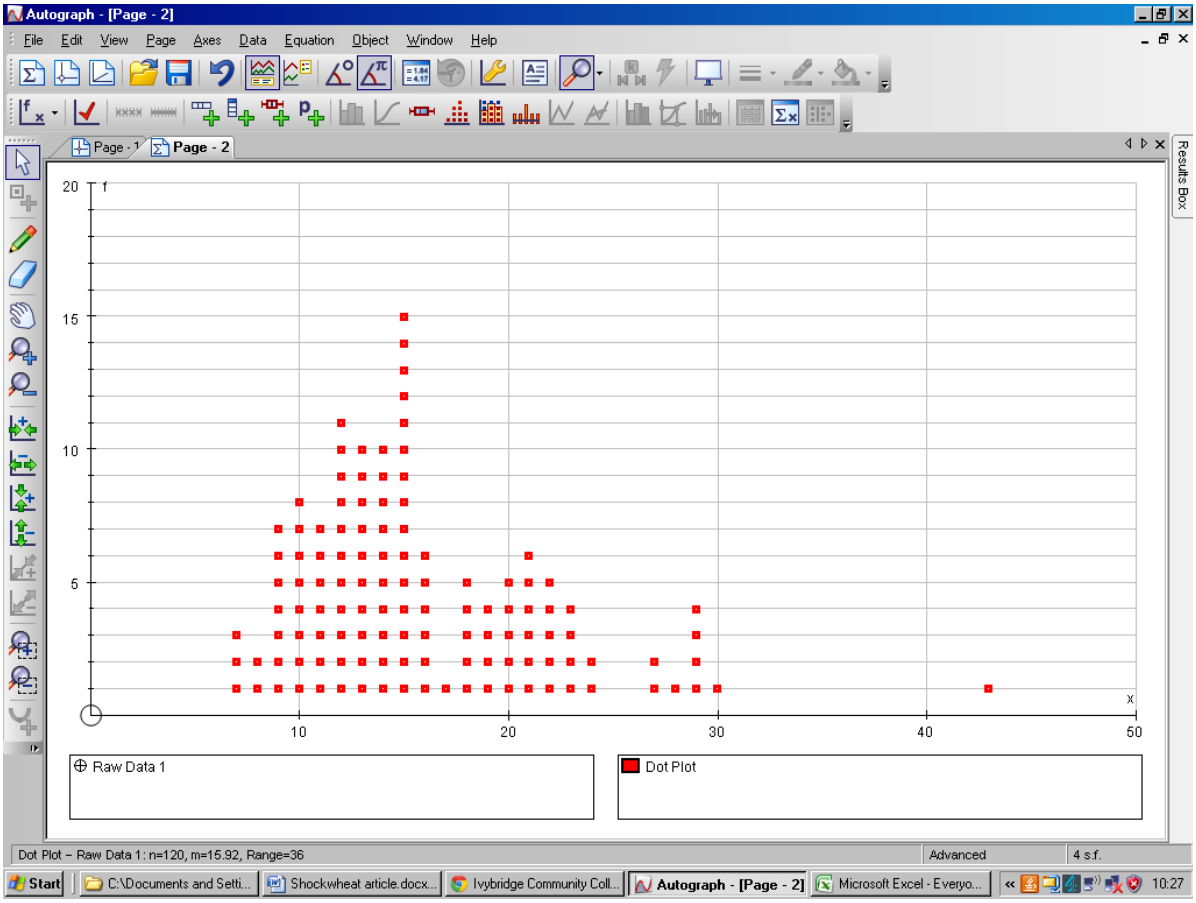
Had to wait until…. 17 to collect them all.

Upon returning to our classroom and analysing the results, one of my core mathematicians commented that if we were to run the simulation using dice, the mean would be higher, due to there being a fair amount of 'cheating' by the year 10 students.

For me, this was an important moment, partly because the direction the work had taken had been dictated by one of my students, but also because we now had two data sets to compare and the students had a real interest in finding out the answer to a hypothesis they had generated themselves. We ran the simulation using dice but quickly realised that with just the six of us, generating sufficient data was going to be time consuming and tedious.

Fortunately myself and a colleague of mine had previously investigated the possibility of running the simulation using a spreadsheet, so I was able to employ this and generate large amounts of data quickly and (relatively) painlessly.

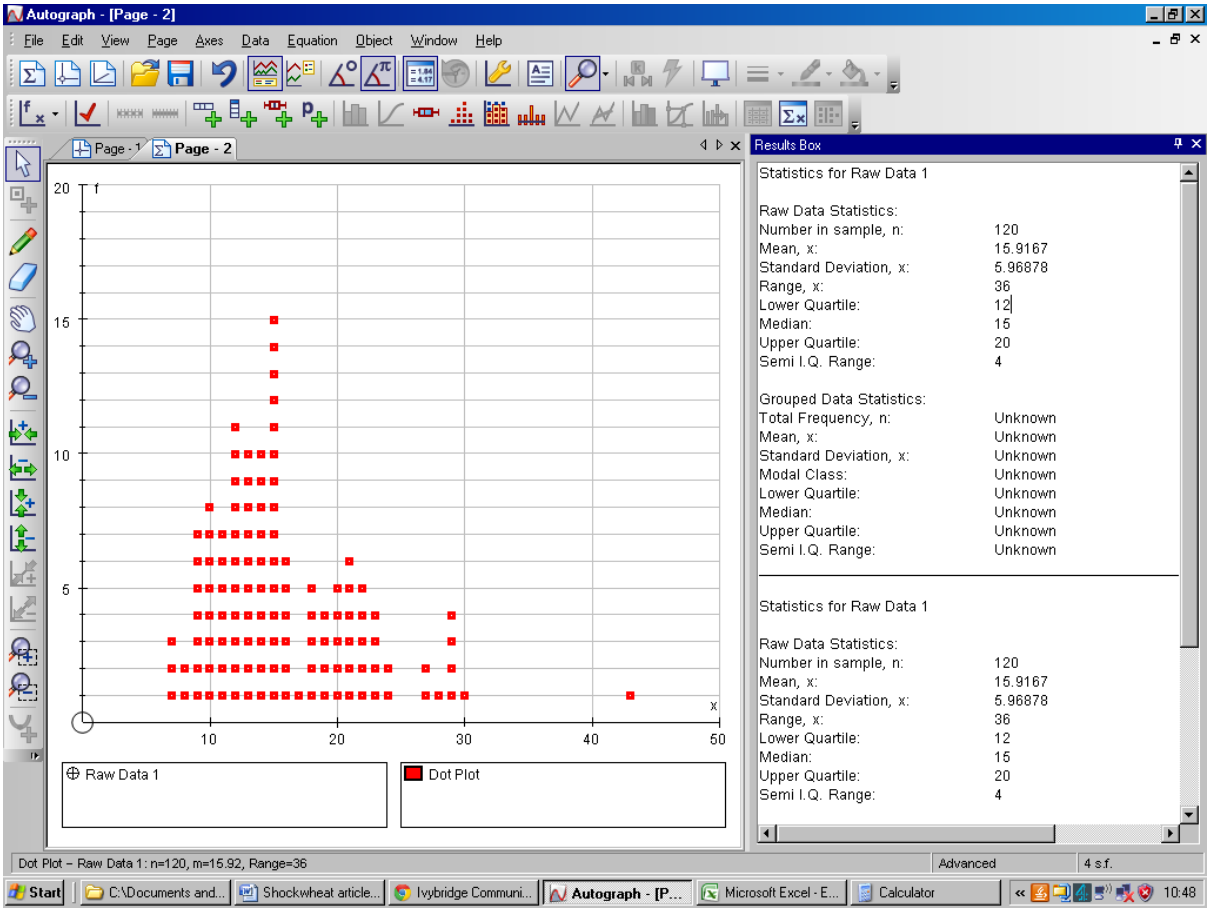
By showing the students the spreadsheet page whilst not providing them with any of the formulae, they had to consider how the output in each cell had been created and, as a result, they not only got to use many spreadsheet functions that they had not met before but they also began to think like a spreadsheet programmer. Each student created and then ran the simulation thirty times. We pooled results and exported them into a statistics page in Autograph where we displayed them as a dot plot (see below)



Whilst the results on the whole were not all that surprising, showing an obvious positive skew, it was immediately clear that one result in particular stood out as being unusual. The probability of getting a card for the first time on the 43rd attempt (irrespective of whether the other five cards in the set have been obtained or not) is 0.0000787! The students were immediately drawn to this result and a conversation on whether an unusual result was an outlier or not ensued.

Having taught A level Statistics for many years it surprised me that I had never introduced the concept of standard deviation in this manner before, always preferring to consider spread of data first and mentioning the determining of outliers almost as a neat ‘by-product’ once the students had learnt how to process the statistic.

I immediately sensed this approach was more successful – here was a ‘freak’ result but was it an outlier? A real question that the students could all relate to based on data they themselves had generated.



Rather than go immediately into the processing of standard deviation, I used the results box on Autograph to display the key summary statistics for the data set. From this the students were able to determine whether the result in question was an outlier or not using both standard deviation and interquartile range.

3. Extensions

In subsequent lessons they were reminded how to use cumulative frequency graphs to determine interquartile range (we also did some work on box plots) and were taught how to find the standard deviation. We have worked with listed and grouped data and have examined the errors in the latter. The students have enjoyed trying to match Autograph (and have been quite competitive when working from cumulative frequency graphs in trying to be most accurate) and my instinct is that approaching the concept from this direction has been far more beneficial as it has come about from a need to know the answer to a real question the students themselves have been instrumental in generating.

I have no idea whether Derek Robinson's plan for the Shockwheat activity covered the same mathematical landscape that my core maths class traversed as I only skim read his article (on purpose, I hasten to add). For me, I was excited by the resource, could sense that it would lead to some interesting places and then let the data take care of itself. Interestingly, if the result of 43 hadn't occurred (which could easily have been an error made by one of the students when they transferred

the data into their results box) an opportunity to explore outliers and the associated mathematical concepts surrounding them would probably have been missed!

For me, this experience has been particularly noteworthy because it epitomises one of the great potential strengths of the core maths course (and also highlights, perhaps, what has been missing in all those other courses we have taught for so long now). Probably for the first time in my teaching career, I am no longer having what I am teaching dictated by a scheme of work or a set of objectives. Of course, the set of objectives exists but, with the extra freedoms afforded by the core maths course and with the shift of emphasis away from content and into context (and by using the rich starting points provided by, amongst others, the CMSP) it has been exciting to have the work we cover dictated by the task, free to explore avenues of learning that occur naturally, ticking off objectives along the way. I feel it is of paramount importance that this aspect to the course – the ability to 'wend' our way through mathematics – is preserved and that core maths remains a special and, crucially, different experience for our students.