National Association for Numeracy and Mathematics in Colleges
NANAMIC

New College Huddersfield – 31st October 07

A Training Day with Susan Wall

How motivating it is to work with such a gifted teacher as Susan Wall. She shared so many of her creative but very practical ideas to engage students in the understanding of mathematics during our NANAMIC day in Huddersfield.

Susan's introduction explained her philosophy for maths activities. She uses certain 'activity types' and these can be adapted by content to fit different levels. Although the focus for the day was mainly aimed at GCSE and AS level, other levels were covered too and she shared an enormous number of examples to show how any activity can be made accessible to a variety of learners.

She asked us to think of ourselves as students. We could be A* or low GCSE grade and this put those of us who have not taught much A level recently, or at all, at our ease.

Starters that promote discussion:

We started off in pairs looking at an 'Odd One Out' activity. We had to justify each one of the three equations $y = 3x + 4$, $2y = 6x – 7$ and $3y + x - 4 = 0$ as being the odd one out in as many ways as we could. We recorded this on sugar paper, no notes were allowed anywhere else, and we were urged to put down all our thoughts. The rule was "*Cross outs are OK, even for girls!"* This wasn't the place for 'neat methods' but for looking and noticing all the possibilities.

After five minutes, Susan collected some of the ideas on the flip chart for further discussion. She explained her strategy of often including one of her own statements in this type of plenary (unknown to the students) to cover any gaps and ensure that all the key learning objectives or common misconceptions are thoroughly explored. She picked up on the word '**notice**'. She really wants students to notice things. Even noticing trivial things and sharing them is useful, encourages a wider perspective for all and leads to deeper learning.

The Odd One Out activity is easily adapted to other equations such as quadratics, or circles. But a word of warning ….. to make the activity effective choose the numbers quite carefully. For instance in the linear equations the coefficients allow for the same gradients and intercepts but not at first glance. The activity can also be extended by using questions such as "*What would I need to change to make it the same y-intercept or gradient or …..?*"

For examples to use with learners at other levels Susan's suggestions included

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Justify each one as the odd one out in as many ways as you can.

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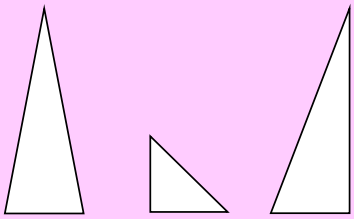
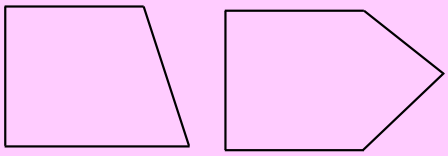
Justify each one as the odd one out in as many ways as you can.



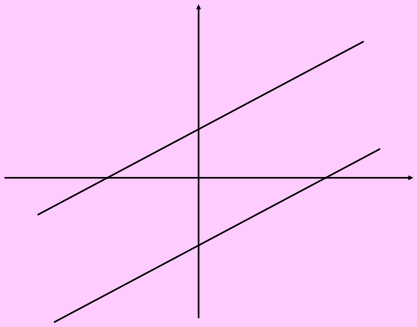
Alternatively the tasks can be worded in different ways. Information on costs of different types of soft drinks or mobile phones could be accompanied by an invitation to students to say which they would prefer and why.

Given one of the diagrams below, we could ask "*What is the same and what is different*?"

What is the same and what is different?



What is the same and what is different?



These activities encourage learners to voice their thoughts, to put it into words, to practice and become comfortable with the language of mathematics.

For example in the middle of an AS course, when students have met some calculus, the lesson might start with:

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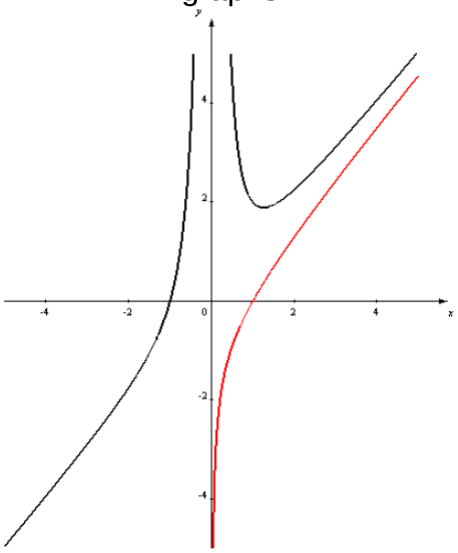
What is the same and what is different between the graphs?



We set to again to try this one out. We worked together in twos or threes. Our levels of knowledge varied but all were able to contribute something and the mini white boards were useful for jottings and checking ideas. The rich returns which come from starter activities like this give rise to the whole lesson. There is not much preparation for the teacher, but the students do lots of thinking and problem solving.

As Susan explained, all of the starter ideas provide ways to discuss mathematics, to assess learners and to bring out misconceptions. Have learners understood the key concepts? If the answer is yes, then maybe the lesson follow up is not needed.

Activities that are challenging yet accessible

Learning grids:

In the afternoon we were introduced to another type of activity. Susan provided large A3 grids containing 18 statements with accompanying sets of small cards. In this example the statements all related to circles, some more challenging than others. For example, *'This circle passes through the point (5, 12)'* or, *'These circles have the same radius'* or, *'This circle does not intersect either axis'*. The small cards each had the equation of one particular circle and in our small groups we worked together to match the equations to the statements. This might seem a big task for anyone not too sure about the topic, but as usual Susan has a strategy which makes it possible for learners to achieve at different levels. She suggested that in giving such a task to students, she would make clear her expectations. *"In the time I allow you, cover at least five sections."* Students then know what they should achieve, but the more able still have the scope for solving more challenging problems. In circulating among the student groups

ensure that you don't just ask what might have gone wrong, but ask them to justify what's right. Again this is an activity which encourages students to look critically and **notice** the structure of the equations. *"$(x + 3)^2 + (x + 2)^2 = 4$ …. two squares added up …. Oh! Pythagoras!"*

But don't despair if this is not the level of your learners. Susan has examples of similar learning grids at Entry Level. Have a look in the Thinking Through Mathematics community on the NCETM web portal at **www.ncetm.org.uk** where she has posted a 'Numbers and Language' grid in the 'Mostly Number' folder, using statements such as *'These numbers are factors of 36'* or *'These numbers have a total of 20'* or *'These numbers have a product of 24.'* In this case the set of small cards for matching to the statements are simply the numbers from 1 to 99.

Card sorts with a difference:

For this activity you need small cards each with a different way of writing the same and similar things. In pairs we tried cards on standard form with numbers such as
480 x 100, 0.00048 x 10^9, 48 x 1000, 4.8 x 10^5, 160 x 3 x 10^4, 4.8 x 10^6 etc..

The idea is to sort them into lists of equivalent ones, but you do not know how many lists there are or how many there are in each list. Some are relatively easy but then it gets tricky. For those who finish quickly, blank cards are provided to add some of your own, so that you can be as adventurous as you want. For assessment you can compare lists with another pair.

Posters in pairs:

'Everything you know about …..' was the next activity type. This involved each group of two or three writing down as many expressions as they could think of that use indices but simplify to give the answer 8. We recorded our answers spider diagram style, around a huge 8 written in the middle of a flip chart sheet. After a few minutes we joined with another small group to compare and share. Anything that one pair had and the other did not, was added to the diagram so that both ended up the same, but a pair was not allowed to add something that they did not understand. They had to get it explained and to check it before they added it to their poster. We then moved again to compare and share with a third group. It was fun and we ended up with all sorts of solutions that no one learner could have thought of in the time involved. Here is another activity with little preparation involved for the teacher, but lots of thinking, sharing, peer assessment and enjoyment for the learners. Susan's strategy for rounding this one up, is to pick a statement from each poster and ask one of the student group to explain/justify it.

Questioning:

We then did some role play with a script provided by Susan which highlighted all the poor sorts of questioning techniques we sometimes use as maths teachers.

This was her way of introducing us to more effective questioning, providing examples of closed questions and then opening them up so that a variety of responses could be expected. We were asked to show equations of lines with gradient 4 on our mini white boards. Each one had to be different to our neighbours. A few were chosen by Susan and listed on the flip chart. We voted whether we thought they were correct or not and then looked in detail at the ones with the most ticks and the ones with the most crosses. Finally in teacher mode, Susan asked if anyone had anything on their board they would like us to check.

Using your mini white boards write down an even number. ("*Well that's a nice open question with lots of possible responses*.") But from such an open question, begin to add constraints slowly, one at a time, and narrow it down which creates a buzz of discussion. Ask for one response per group so that no one 'feels bad' if the answer is wrong. They can always blame the others in the group.

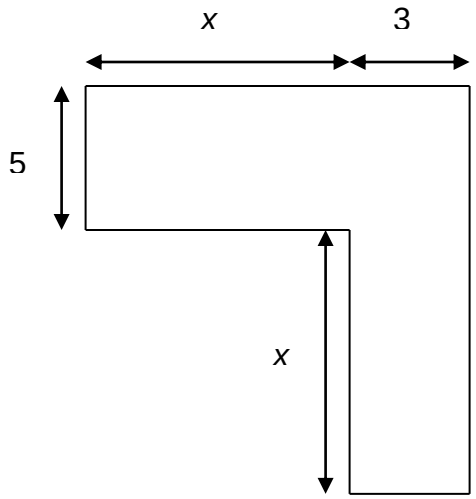
But less than 100?
And between 60 and 80?
And a multiple of 3?
And a multiple of 4 as well?

This type of strategy works well on an interactive whiteboard where students can be asked to sort into categories such as true or false. If students are made aware that all are expected to take part, for example by always asking those who don't come out to the board to move things about, to be the ones who have to explain or justify the results, then you set a culture of ensuring that all take part. Additionally moving items about on the interactive white board is non permanent, which again makes it an activity within the students' comfort zone and if it is also a group task and the response is a group response, then it makes it possible for all to take part without feeling that any one particular learner is responsible for 'getting it wrong' because we all make mistakes.

Opening up the possibilities:

- Give a typical text book question, but 'open it up, by asking *"What difference would it make if ……?"*
- Just give a diagram and ask the students *"What question could you ask?"*
- Provide a chart or graph from the Office of National Statistics and ask students to *"Write a hard, a medium and an easy question which can be answered from the graph or chart."*
- Ask student to bring in their own bills and then get them to pose the questions.
- What happens when ……?
- What happens if I change ……?
- Convince me that …….
- How would you describe …….?
- How would you make it true that ……?

Thinking questions



How many ways can you write an expression for the area of the shape?

A circle passes through the points (0, 1) and (0, 5). What else might be true about it?

Provide a graph with several intersecting quadratic curves. Provide a list of corresponding equations and ask students *"Which equation belongs to which curve and why?"*

The point (3, 4) is one vertex of a rhombus. Find other possible vertices and justify your choice.

Thinking questions are questions that can be attempted at a variety of levels. For instance at one level learners might find solutions to the rhombus question by drawing, while at higher levels solutions might involve equations of lines, simultaneous equations, use of sine or cosine rule or vectors and transformations.

Give a thinking question for homework. High achievers may get to generalisations, but everyone gets somewhere and it provides a good way of assessing students.

This was an extremely productive day providing us all with challenge, surprise, engagement, satisfaction, enjoyment and a need to try things out. That's maths!

Thank you Susan. Thank you NANAMIC.

For further information re NANAMIC see www.nanamic.org.uk or email Lesley Way, Administrator and Conference Organiser at ways2teach@ntlworld.com

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