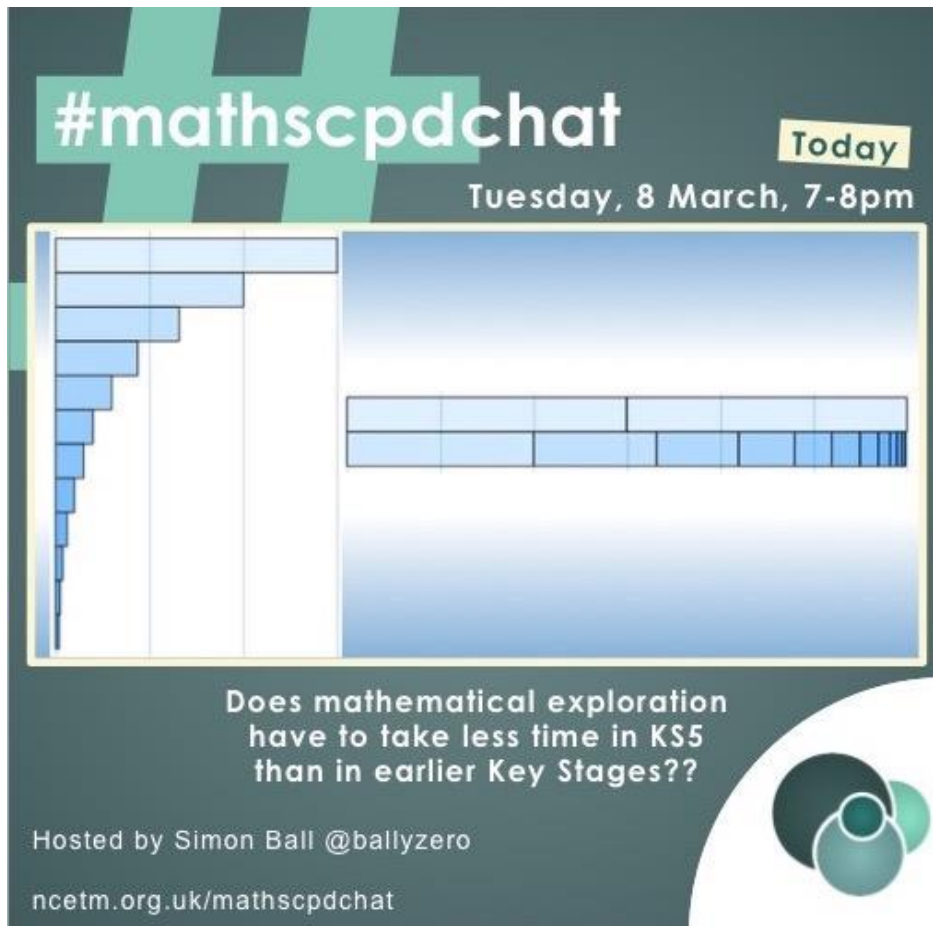# #mathscpdchat 8 March 2022

Does mathematical exploration have to take less time in KS5 than in earlier Key Stages?
Hosted by [Simon Ball](#)

*This is a summary of the discussion – to see all the tweets, follow the hashtag **#mathscpdchat** in Twitter*

The links shared during this discussion were:

[Active A-level Mathematics](#) which is a collection of ideas from Susan Wall for use in the A-level mathematics classroom. The tasks are designed to engage student participation, promote discussion and enhance understanding. The collection is sub-divided under a variety of headings, such as 'Further Thinking Questions', 'Circle Geometry', 'Sequences and Series', 'Properties of Functions', 'Sometimes, Always, Never', 'Indices', and so on. It was shared by [Rob Southern](#)

Don Steward's collection of resources for mathematics teaching which is a vast collection of original tasks designed by the late Don Steward. It was shared by webmathscouk

Underground Mathematics which are free resources from the University of Cambridge created to support teachers of A-level mathematics in the classroom. These resources help students build firm foundations for mathematical understanding by connecting ideas and developing techniques. They are designed to stimulate curiosity and elicit discovery of ideas, while encouraging students to pose questions, reflect and collaborate. It was shared by Mary Pardoe

A full illustrated summary of the discussions in this #mathsCPDchat follows.

The screenshots below show conversations and single replies generated by Simon's first and second questions. Examples were shared of tasks that provide opportunities for students to explore possibilities and collaborate. Contributors also discussed implications of teachers' various interpretations of 'mathematical exploration', 'discovery learning' and 'direct instruction'. **Click on any of the following screenshots of a tweet to go to that actual tweet on Twitter.** The conversations were generated by this question from Simon Ball:

Simon Ball @ballyzero · 15h   ...

So, we'll open up proceedings with this: what does student exploration look like in KS5 Maths? #mathscpdchat

Two conversations and two 'single' replies were generated by this question … this conversation between Rob Southern and Simon Ball …

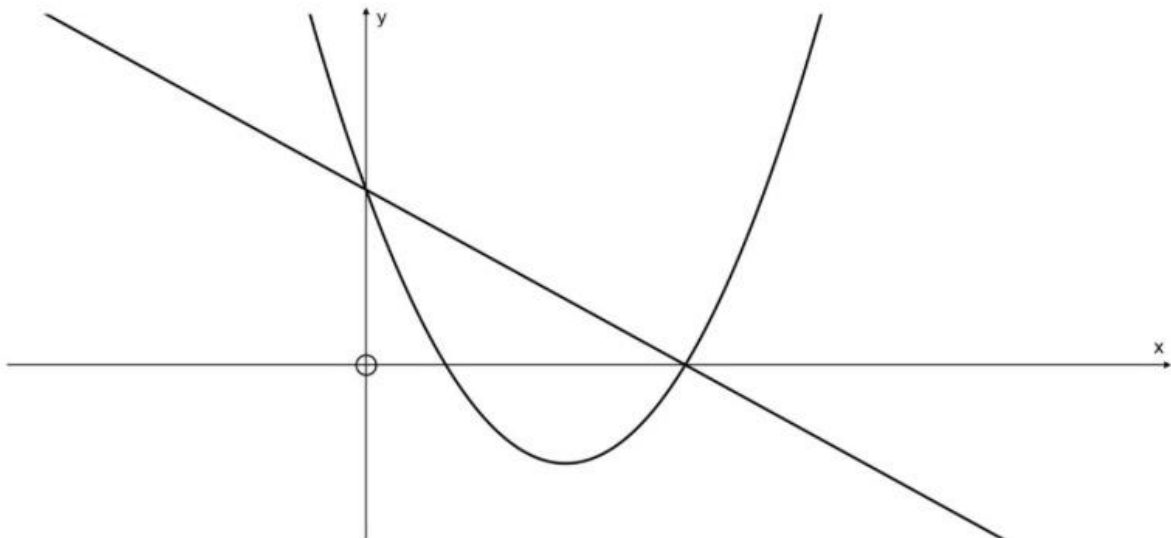**Rob Southern** @mrsouthernmaths · 15h   ...
Replying to @ballyzero

Problems that give students the chance to explore different strategies or achieve multiple answers, possibly with the objective of generalising. A couple of examples to follow…#mathscpdchat

Rob Southern @mrsouthernmaths · 15h   ...

Line and parabola thinking question. I shamelessly stole the style of this from Susan Wall, whose resources are all available on the STEM website.

Suggest possible equations for the line and the parabola.

Justify your answer.

Generalise your answer.

Simon Ball @ballyzero · 16h   ...
#mathscpdchat This is a beautiful one!

Rob Southern @mrsouthernmaths · 15h ···

And this introductory activity on moments. #mathscpdchat

Investigating Moments.

A man of mass 70kg is playing on a seesaw with his two children, who have masses of 18kg and 12kg. The seesaw, AB, is 5 metres long and has a mass of 20kg. The seesaw is modelled as a uniform rod and rests on a smooth support at the point **P**, which is the midpoint of **AB**, as shown in the diagram.

A   P   B

20g
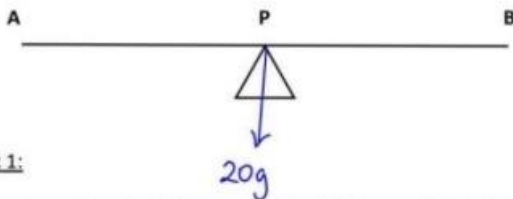
Task 1:

Suggest positions that the man and his children could stand so that the seesaw remains in equilibrium.

Task 2:

One child sits at the point **A** and the other child sits at the point **B**. The man stands with his feet either side of the point **P**. He distributes his weight evenly between his two feet. The system remains in equilibrium.

How far from the point **P** could the man place each of his feet?

Justify your answer.

Generalise your answer.

Task 3:

The children remain at the points **A** and **B**. The man now places his feet on either side of **P** and equidistant from **P**. The system remains in equilibrium.

How could the man distribute his weight?

Justify your answer.

Generalise your answer.

Simon Ball @ballyzero · 16h ···

Thanks for sharing those with us, Rob! The moments one looks grand. How do students take to these kinds of tasks, in your experience? #mathscpdchat

Rob Southern @mrsouthernmaths · 15h ···

They need a bit of guidance in the first instance. Get them working on whiteboards so that you can encourage and guide subtly. Develop an environment in the classroom where collaboration is encouraged. Get the students to support and challenge each other. #mathscpdchat

Rob Southern @mrsouthernmaths · 15h ···

Replying to @ballyzero

Often with these tasks, students want to get to the one correct answer, or they find one answer and think that's sufficient. This is where the idea of generalising comes in. #mathcpdchat

Simon Ball @ballyzero · 15h ···

I find that a lot. They can get quite a fixed idea of what maths is, and chasing that single answer is top of the list of clues! #mathscpdchat

… and this conversation between webmathscouk and Simon Ball …

webmathscouk @Dids31 · 15h   •••

Replying to @ballyzero

I used a Don Steward 6 frequency tables resource, asked students to order in terms of standard deviation, introduced how to calculate and got great discussion and understanding of the concept.

Simon Ball @ballyzero · 15h   •••

That sounds like a great one that I might steal for next time! Also a great point - we can explore in Stats, too! #mathscpdchat

webmathscouk @Dids31 · 15h   •••

The data set used
#mathscpdchat

A

x	f
1	99
2	56
3	31
4	17
5	10
6	5
7	3
8	2
9	1
10	1

B

x	f
1	17
2	64
3	88
4	85
5	74
6	54
7	36
8	22
9	11
10	3

C

x	f
1	7
2	13
3	20
4	26
5	32
6	38
7	46
8	52
9	59
10	65

D

x	f
1	4
2	11
3	22
4	36
5	49
6	61
7	68
8	72
9	60
10	8

E

x	f
1	4
2	12
3	25
4	41
5	54
6	54
7	41
8	25
9	12
10	4

F

x	f
1	8
2	25
3	9
4	45
5	63
6	19
7	30
8	52
9	45
10	8

Simon Ball @ballyzero · 16h

A wonderful resource from webmathscouk! Thank you very much. #mathscpdchat

webmathscouk @Dids31 · 16h

Replying to @ballyzero

Courtesy of the great and much missed Don Steward.

Simon Ball @ballyzero · 16h

A task designer of incredible skill. #mathscpdchat

… and these 'single' tweets from Simon Ball and Mary Pardoe:

Simon Ball @ballyzero · 15h

Replying to @ballyzero

I have to admit to not doing much of this. My favourite one is finding the value of R when you're reducing Acosx + Bsinx to Rsin(x + alpha) forms by playing around with functions of the original form. #mathscpdchat
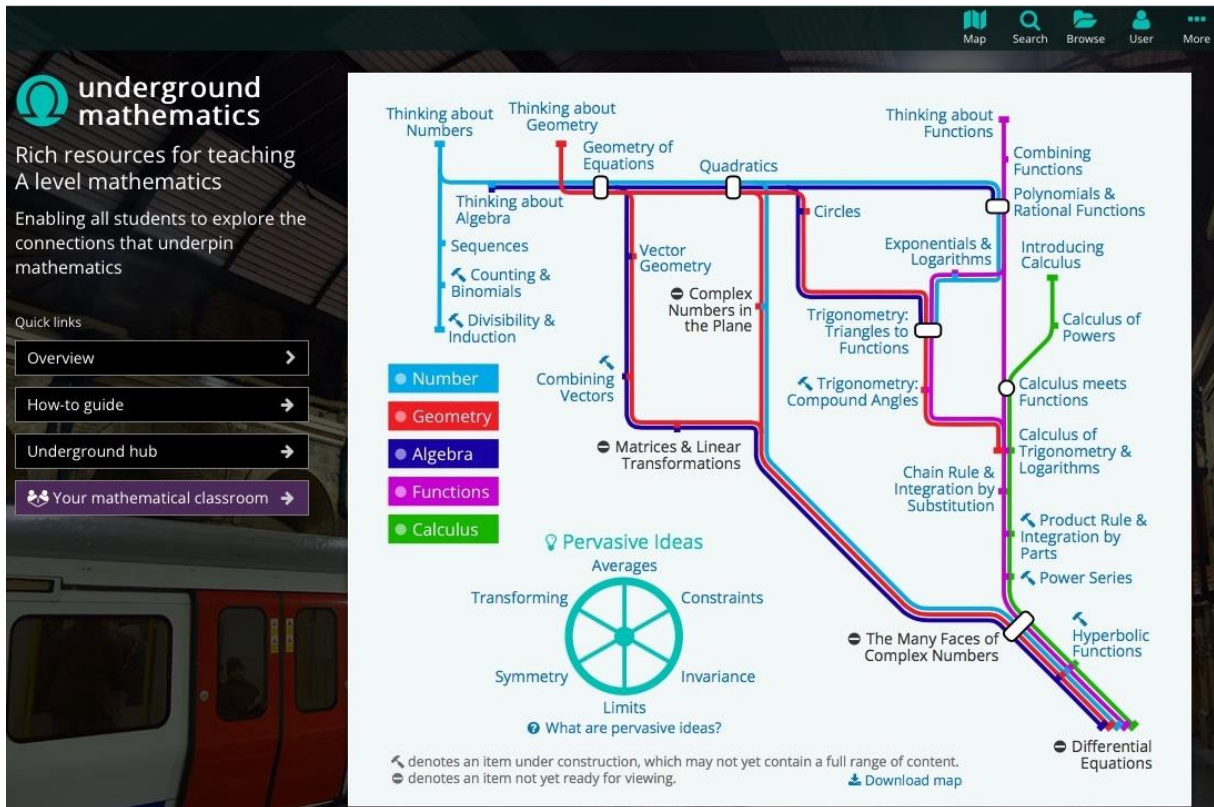
Mary Pardoe @PardoeMary · 15h

Replying to @ballyzero

Ideas here!!!!

undergroundmathematics.org

#mathscpdchat

This second 'main' question from the host, Simon Ball, …

Simon Ball @ballyzero · 16h

How much exploration-style learning do your KS5 students do in a typical year? Would you prefer to do more? Would you prefer to do less? #mathscpdchat

… generated a discussion between Simon Ball, Susan Whitehouse, Mary Pardoe, mathsasas and Dattamatics …

Susan Whitehouse @Whitehughes · 16h

Replying to @ballyzero

I'm not teaching in a school/college at the moment but when I am, I'm not sure my KS5 teaching can he classified as discovery learning or as direct instruction. The students do a lot of making connections for themselves but I also do a lot of directing of where that's going.

Simon Ball @ballyzero · 16h

In my head I call that 'directed discovery', and I'd like to do far more of it than I do! Do you have any guiding principles as to how you set up such activities? #mathscpdchat

Mary Pardoe @PardoeMary · 16h

Doesn't 'exploration' mean exploring implications of an idea, or procedure applied to an idea, mean exploring it (for at least a while) for/by yourself? I'm afraid that the phrase 'discovery learning' may have gathered some negative 'gloss' over the years! #mathscpdchat

Susan Whitehouse @Whitehughes · 16h

Yes, but I think that can be something as simple as a well thought out question where students have the room to think and play around before being told the answer

Susan Whitehouse @Whitehughes · 16h

Replying to @ballyzero

The key thing is always knowing your aims. Why have you chosen a particular activity, what connections do you want the students to make, what questions can you ask to help them. Experience comes in when things go off piste - knowing when to rein things in and when to be flexible.

mathsasas @mathsasas · 15h

I think I have nailed this with Year 11, but with KS5 it often feels like there isn't enough time to follow them down their line of thinking, and direct instruction becomes really appealing. Have you found this at all with the pace of KS5?

Susan Whitehouse @Whitehughes · 14h

I think it's hard; you have to have the courage of your convictions that it will pay off in the longer term. It is genuinely quicker to deliver the later parts of the course if the students have made the connections in the earlier stages. But it is a leap of faith.

Dattamatics @Dattamatics · 16h

Replying to @ballyzero and @Whitehughes

Also part of it is experience. e.g. finding the sum of $1/2 + 1/3 + 1/4 + 1/6 + 1/8 + 1/12 +...$ you may want to pre-empt with an easier question of splitting something up into 2 parts, which may prompt them into trying to split this up into 2 GPs, which they may not spot otherwise

… and the discussion continued, prompted by two tweets from Rob Southern, and including Susan Whitehouse, Simon Ball, Tom Bennison and Chris McGrane:

Rob Southern @mrsouthernmaths · 16h

Replying to @ballyzero

See, I think you can "do exploration" in every lesson if you give the students the opportunity to try problems for themselves, applying their skills to new content. Use whiteboards, get them talking to each other and then tease out the key points. #mathscpdchat

Rob Southern @mrsouthernmaths · 16h

You don't need to do multiple teacher-led examples from the front if each one builds upon the previous one because students can make those links themselves. #mathscpdchat

Susan Whitehouse @Whitehughes · 16h

Yes, it does depend what we mean by discovery learning, and I'm not sure everyone means the same thing. As I've said before, good discovery learning, where the teacher is on top of the direction, is very similar to good direct instruction, where probing questions are asked.

Simon Ball @ballyzero · 16h

Replying to @Whitehughes and @mrsouthernmaths

I'd argue for a varied diet of both, of course! Would you say a good blend is possible? #mathscpdchat

Susan Whitehouse @Whitehughes · 16h

I would want every lesson, even every activity to be a blend of both! But I don't care what label it's given. I want the students free to develop their own understanding, but the teacher ultimately in charge of the direction of the lesson.

Rob Southern @mrsouthernmaths · 16h

Perfectly summarised!

I agree that we sometimes dig a hole for ourselves by talking about "direct instruction" and "discovery" because no one can agree on what these things mean anyway. #mathscpdchat

Tom Bennison @DrBennison · 15h

I think people also confuse direct instruction and Direct Instruction too. #mathscpdchat

Susan Whitehouse @Whitehughes · 16h

However ineffective discovery learning and ineffective direct instruction both exist, and, in my experience, are miles apart from each other. Except in both being ineffective!

Chris McGrane @ChrisMcGrane84 · 16h

Couldn't agree more. A well designed task where pupils are able to stumble a little is fine, so long as we are there to help them get back on their feet.

Simon's second question also prompted these comments from Tayyub Majeed, Simon Ball and Tom Bennison:

Tayyub Majeed @tm_maths · 16h

Replying to @ballyzero

I do prefer a lot of direct instruction type lessons with KS5. Think they respond better with examples/exercises. I haven't built up a culture of discovery maths in my own lessons. Having said that, I don't have enough experience to get them to make links.

Simon Ball @ballyzero · 16h

I feel the links point is important. They can be quite hard to get across! I also feel we must make sure we're doing things that actual mathematicians do: play around, spot things, generalise, check hypotheses, and so on. #mathscpdchat

Tom Bennison @DrBennison · 16h

Replying to @ballyzero

I'm not sure you can split into this distinction if you are teaching the mathematics as opposed to teaching to a test.

(to read the discussion sequence generated by any tweet look at the 'replies' to that tweet)

There were no direct replies to Simon's third question …

Simon Ball @ballyzero · 16h

Do you do more student exploration/discovery-type activities in KS3 or KS4 than KS5? #mathscpdchat

… although it was addressed in response to his fourth, and last, question …

Simon Ball @ballyzero · 16h   ···

So it seems we're generally in favour of activities where the students can explore and play with the maths a little, across all three elements of A-Level Maths! What are your do's and don'ts for exploration-style learning? #mathscpdchat

… which prompted this conversation:

webmathscouk @Dids31 · 16h   ···

Replying to @ballyzero

Do's - think carefully about what you are doing and why. Questions - Is it better than direct explanation to develop understanding? Will it meet the objective? How to group students? How students apply to solving a problem or a task with new info.
#mathscpdchat

Simon Ball @ballyzero · 16h   ···

How do you make the decision if exploration is better than direct explanation? #mathscpdchat

Mary Pardoe @PardoeMary · 16h   ···

Can't students learn from both. If they're interested won't they naturally (want to) explore ideas anyway?
#mathscpdchat

webmathscouk @Dids31 · 16h   ···

Replying to @ballyzero

Sadly, and honestly, quite a lot of decisions come down to time. How much time do we have to cover the topic/content. Can we afford to spend a lesson in "playing around and finding out"?
#mathscpdchat

webmathscouk @Dids31 · 16h   ···

Also, tasks and resources at hand. There is far more available at KS3 and KS4 than KS5, I have found.
#mathscpdchat

Tayyub Majeed @tm_maths · 16h   ···

This is my opinion too. Far too much out there for KS3/4. For KS5, there's too much direct instruction sort of examples and lack of support in a lot of places to teach ALs in any other way. #mathscpdchat