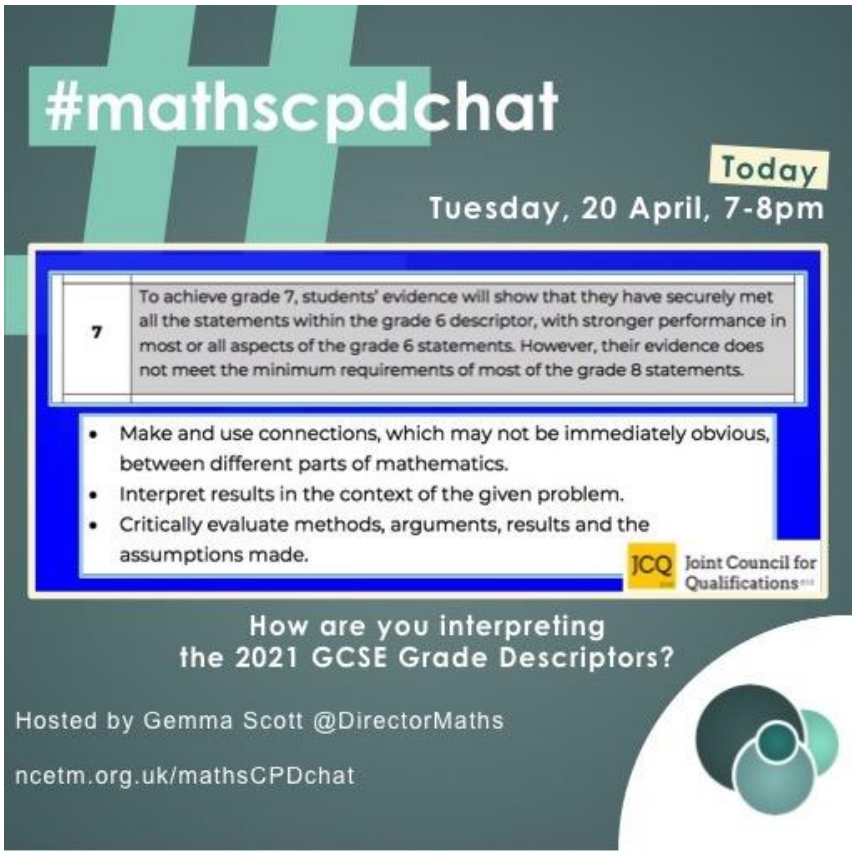
#mathscpdchat 20 April 2021

How are you interpreting the 2021 GCSE Grade Descriptors?

Hosted by Gemma Scott

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



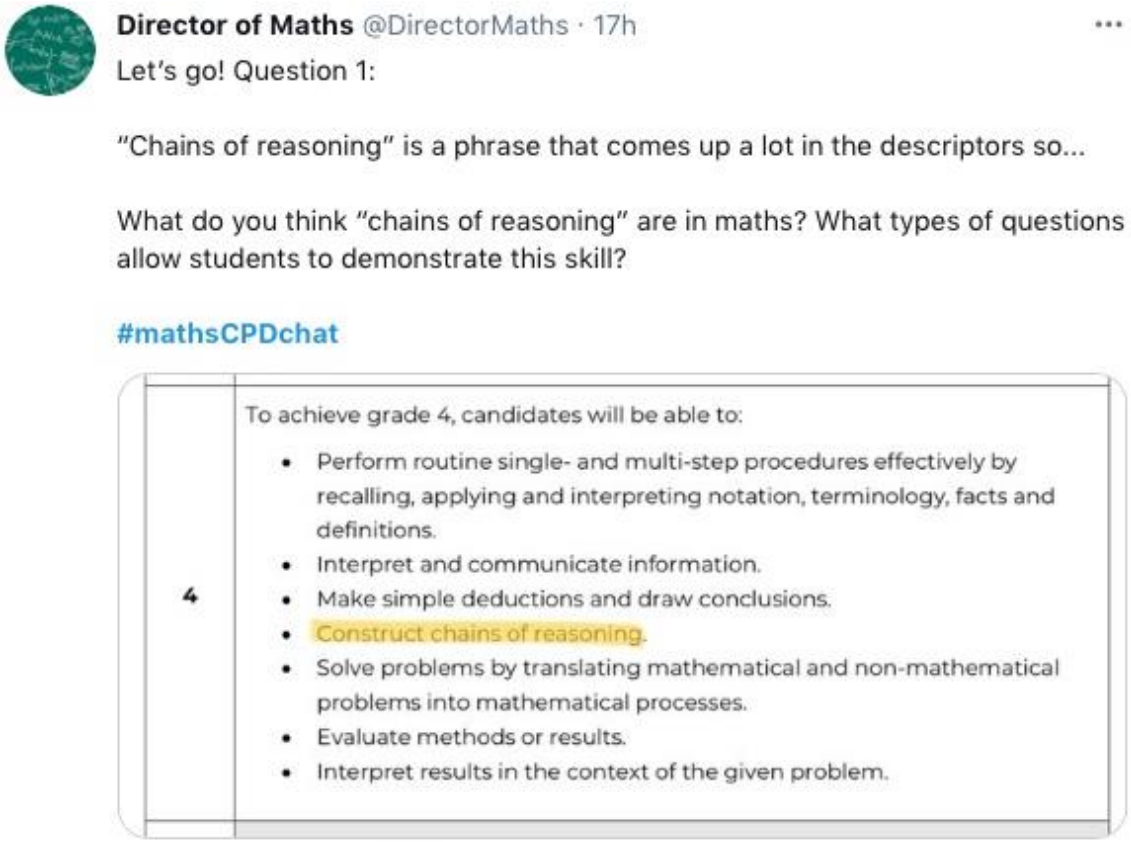
Among the links shared during the discussion were:

GCSE grade descriptors to assist with determining grades which is a publication from the Joint Council for Qualifications. It was shared by Gemma Scott

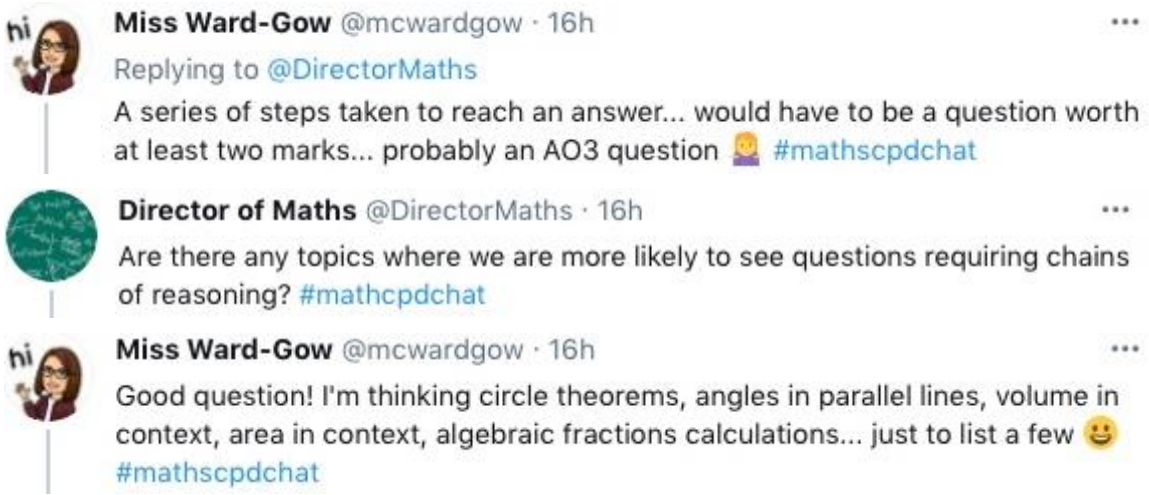
Improving Language Use in Maths which is a Loughborough University Professional Development video by Dani Quinn. It was shared by Alice Ward-Gow

The screenshots below, of chains of tweets posted during the chat, show parts of several conversations about interpreting the phrase ‘chains of reasoning’, which occurs frequently in the 2021 GCSE Grade Descriptors. **Click on any of these screenshots-of-a-tweet to go to that actual tweet on Twitter.**

The conversations were generated by this tweet from Gemma Scott:



and included these from Alice Ward-Gow, Gemma Scott and Mary Pardoe:



Director of Maths @DirectorMaths · 16h

Hmmm algebraic fractions is a really interesting one because with a lot of the others the students are writing words as their "reasoning" but with alg fractions it's more like a mathematical proof 🤔 good thinking! #mathscpdchat

Mary Pardoe @PardoeMary · 16h

Isn't a mathematical proof a chain of reasoning?
#mathscpdchat

Miss Ward-Gow @mcwardgow · 16h

Would this then suggest that any "show that" questions would also be "chains of reasoning"? 🤔 #mathscpdchat

these from Mary Pardoe, Gemma Scott and Jenny Hill-Parker:

Mary Pardoe @PardoeMary · 16h

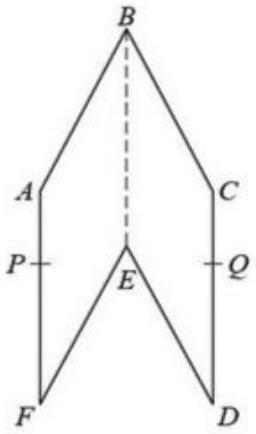
Replying to @DirectorMaths

Here's a Higher one ...

#mathscpdchat

Example 9: 2017, Edexcel, Higher Level, Paper 1, Question 22

The diagram shows a hexagon $ABCDEF$.



$ABEF$ and $CBED$ are congruent parallelograms where $AB = BC = x$ cm.
P is the point on AF and Q is the point on CD such that $BP = BQ = 10$ cm.

Given that angle $ABC = 30°$,

prove that $\cos PBQ = 1 - \frac{(2-\sqrt{3})}{200}x^2$

Mary Pardoe @PardoeMary · 16h

Replying to @PardoeMary and @DirectorMaths

... and a chain of reasoning for it ...

#mathscpdchat

Example 9 Parallelogram ABEF is congruent to parallelogram CBED (Given)

Therefore AB, BE and CQ are parallel

AB = BC = x cm (Given)

BP = BQ = 10 cm (Given)

Angle ABC = 30° (Given)

Angle ABE = Angle CBE (Corresponding angles of ABEF and CBED)

Let G be the mid-point of AB

Angle ABG = Angle CBG (triangle ABC is isosceles)

Therefore both E and G lie on the bisector of angle ABC

Angle PBH = Angle QBH (triangle PBQ is isosceles)

Angle ABP + Angle PBH = Angle ABE

Angle CBQ + Angle QBH = Angle CBE

Therefore H also lies on the bisector of angle ABC

AC is perpendicular to BE, AB, CQ (angle bisector of isos triangle perpendicular to base)

PQ is perpendicular to BE, AB, CQ (angle bisector of isos triangle perpendicular to base)

Therefore ACQP is a rectangle (all angles are 90°)

Therefore AC = PQ

$$AC^2 = x^2 + x^2 - 2x^2\frac{\sqrt{3}}{2}$$ (applying Cosine Rule to triangle ABC)

Therefore $AC^2 = 2x^2\left(1 - \frac{\sqrt{3}}{2}\right)$

$$\text{Cos PBQ} = \frac{10^2 + 10^2 - PQ^2}{200}$$ (applying Cosine Rule to triangle PBQ)

Therefore $\text{Cos PBQ} = 1 - \frac{PQ^2}{200}$

$AC = PQ$

Therefore $\text{Cos PBQ} = 1 - \frac{2x^2(2 - \sqrt{3})}{200 \times 2}$ (substituting expression for AC^2 for PQ^2)

Therefore $\text{Cos PBQ} = 1 - \frac{x^2(2 - \sqrt{3})}{200}$

Director of Maths @DirectorMaths · 16h

I think angles questions lend themselves very nicely to showing chains of reasoning, also nice questions to show the differences between candidates #mathscpdchat

Jenny Hill-Parker @JennyHillParker · 16h

Also the longer AO3 questions that require many interlinked calculations with clear explanations given #mathscpdchat

Director of Maths @DirectorMaths · 16h

Yes, things like best buys maybe? Do students find this easy in your experience? #mathscpdchat

Jenny Hill-Parker @JennyHillParker · 16h

My students find it pretty hard. They can perform the individual steps, but I'd love them to 'see' the links between steps with greater ease #mathscpdchat

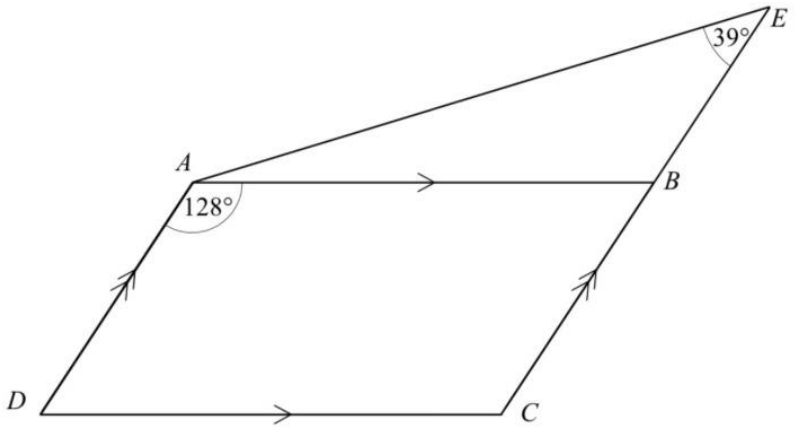
these from Gemma Scott, The 40 Year Old SCITT Student, Kathryn Darwin, Mr Evans, Mary Pardoe and Miss Ward-Gow:

Director of Maths @DirectorMaths · 17h

What might a chain of reasoning look like here?

What might an incomplete chain of reasoning look like?

#mathsCPDchat



ABCD is a parallelogram.
CBE is a straight line.
Angle *BAD* = 128°
Angle *AEB* = 39°

Find the size of angle *BAE*.
Give a reason for each stage of your working.

The 40 Year Old SCITT Student @MrWarnerMaths · 17h

Replying to @DirectorMaths

Consecutive-interior angles between parallel lines (twice) going to D and C, and then angles in a quadrilateral with ADCE. Better, do corresponding angles to get ABE and then angles in a triangle to get EAB

Kathryn MCCT @Arithmaticks · 16h

Replying to @DirectorMaths

I think you'd be missing steps, like a student thinks you're able to follow step one to three without seeing two... perhaps here putting in an angle with no reason. Or using an angle further on in the question, but they haven't actually shown where it came from! #mathscpdchat

Mr Evans Maths @EvansMaths79 · Apr 20

For me a solid chain of reasoning tells a sequenced story of how the pupil calculated the angle.

Director of Maths @DirectorMaths · Apr 20

I've attended a few of @AQAMaths training sessions and their phrase is "make the maths tell the full story". I think that's lovely #mathscpdchat

Mr Evans Maths @EvansMaths79 · Apr 20

I'll also give them a bank of statements to use as reasons at the start. Angles is one topic where I've borrowed a lot of ideas from the English department.

Mary Pardoe @PardoeMary · Apr 20

Replying to @EvansMaths79 @Samathsam1729 and 2 others

I think it's also important to help them gain confidence in giving their own reasons in their own ways ...
#mathscpdchat

Mr Evans Maths @EvansMaths79 · Apr 20

Replying to @PardoeMary @Samathsam1729 and 2 others

This is really important. I sometimes find that some pupils struggle to put enough detail in eg. Because they are on a line etc.

Miss Ward-Gow @mcwardgow · 17h

Replying to @DirectorMaths

Here, I'm taking "chain of reasoning" to mean: giving a reason at each stage... angle BCD = this because... etc #mathscpdchat

The 40 Year Old SCITT Student @MrWarnerMaths · 17h

Replying to @DirectorMaths

Isn't the sequence the chain?

these from Gemma Scott, Jenny Hill-Parker, Mary Pardoe, Tan S and Kathryn Darwin:

Director of Maths @DirectorMaths · 17h

Do you think chains of reasoning come naturally to students or is it an "exam" skill that we need to explicitly teach? #mathcpdchat

Jenny Hill-Parker @JennyHillParker · 16h

Any ideas on how to do this efficiently in the classroom? It seems like such an abstract thing to teach explicitly #mathscpdchat

Mary Pardoe @PardoeMary · Apr 20

Replying to @JennyHillParker @mcwardgow and 2 others

Start by giving lots of opportunities for them to articulate their reasoning ... out-loud preferably?
#mathscpdchat

Tan S @MathsError · 17h

I think it's all about modelling how to do this. I like to talk through my examples, so I'm showing my pupils my chain of reasoning #mathscpdchat

Works well you go over a question that the class has struggled with on the board

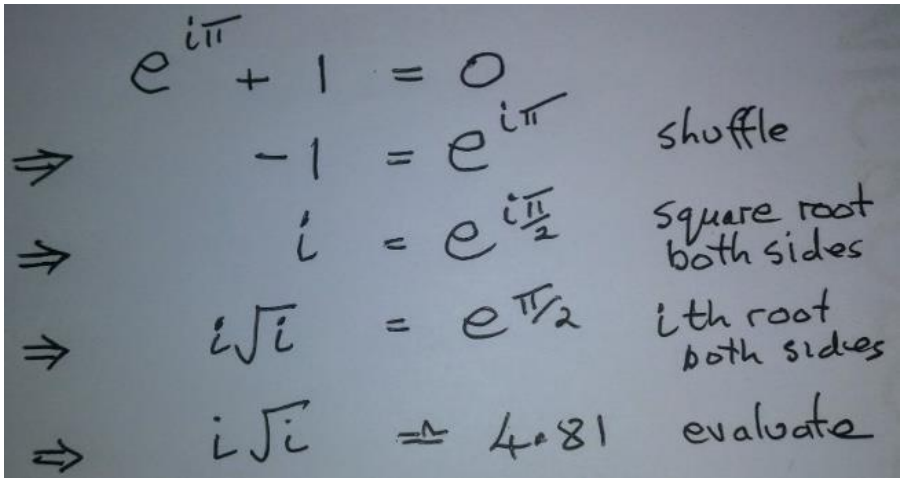
Kathryn MCCT @Arithmaticks · 17h

Same for me. And often when they've done independent work I ask things like "what was your first step?" "Did anyone do this differently? Why?" "Does it matter if I do X or Y first?" Etc.
Lots of WHY to get them to explain. #mathscpdchat

and these from Peter Lacey and Gemma Scott:

Peter Lacey @ecarda1 · 16h

Sorry to crash in but chains of reasoning caught my attention. IMO they can enable mathematical learning journeys. I've attached an eg which starts with Euler's identity and ends with the bizarre notion that the imaginary root of an imaginary number may be real. Quelle surprise!



Director of Maths @DirectorMaths · 16h

I absolutely love the connection to mathematical learning journeys. Thank you for sharing 😊 #mathscpdchat

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

Some of the areas where discussion focused were:

the host asked teachers how they are interpreting the phrase 'chains of reasoning', which appears frequently in the Grade Descriptors; in addition to the discussions reproduced above, comments included:

- some teachers **'took it to mean Qs where they complete a line of work or come to a conclusion (as in an angle chase)'** … they thought that opportunities for students to construct chains of reasoning might **'be restricted to AO2/3 questions'**;
- other teachers have tried providing **'a kind of writing frame'** in order to help students 'see the links between steps with greater ease' … 'students just want to get the correct numerical answer as quick as possible';
- a teacher commented that, in geometrical problems involving finding the sizes of angles 'I stress to pupils that they **number the angles in the order that they calculated them. Then they write their reasons in the order they calculated them**' … that particular teacher also gives students **'a bank of statements to use as reasons'** … another contributor to the chat expressed the view that it is also important to **help students gain confidence in giving their own reasons in their own ways** … to which the teacher replied 'I sometimes find that some pupils struggle to put enough detail in';
- **some teachers see chains of reasoning as students' articulated thought processes** … so students with gaps in understanding 'can't complete their chains' … 'this leads to this, leads to this, etc., shows a deeper level of understanding';
- there was a brief discussion about whether **constructing a chain of reasoning 'is the same as giving reasons'** … that 'reasons should be given for steps in a chain of reasoning' but that there is more to constructing a chain of reasoning than merely giving reasons for mathematical statements;

the host asked how you judge an efficient strategy, and what kinds of question allow students to demonstrate that they can use an efficient strategy:

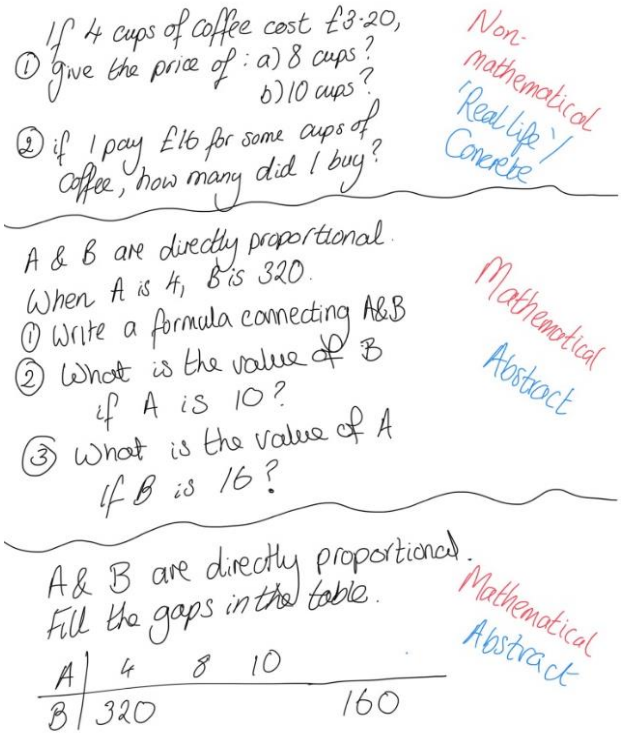
- examples (provided by contributors to the chat) intended to illustrate **the difference between an efficient and an inefficient strategy** included … using 'the formula' to calculate compound interest, rather than working out the interest year by year … working out a percentage using a decimal multiplier on a calculator, rather than 'finding 10% and 1% and building up' … solving the equation $x^2 - n = 0$ by adding n to both sides of the equation then finding the square root of n, rather than 'using the quadratic formula';
- there was some discussion about whether a **student who uses an efficient method, but makes a numerical 'slip'** (and so arrives at an incorrect numerical result) is showing more

competence than a **student who uses an inefficient method leading to the correct result**;

- a teacher pointed out that there are some problems for which there are **equally-efficient alternative ways** to reach the solution;

the host asked what teachers understand/assume to be the difference between mathematical and non-mathematical contexts:

- some teachers think of questions set in non-mathematical contexts as being questions that are **about 'real life' situations** … a teacher tweeted a photo of some quickly 'sketched' 'questions' about the same mathematical relationships/idea and the same numbers:



- there was some discussion about **non-mathematical contexts that confuse students** because the students aren't familiar with the contexts … for example, 'sometimes the 'non-maths' were hard just because students haven't ever seen an electricity meter in real life';
- there was some discussion about examples of **problems in which a problem is presented contextually, students represent, and work on it, purely mathematically, and finally interpret the solution as a quantity in the original context** … for example, forming and then solving a quadratic equation in order to find a 'real-life' quantity … teachers mentioned the commonly-seen nonsensical interpretation of a negative solution of a quadratic equation as a length on a 'real' object;
- there was a brief discussion about **exam questions in which students have opportunities to show that they can 'evaluate methods'** … a contributor to the discussion offered this question as an example:

Q4.

Ibrar bought a house for £145 000

The value of the house depreciated by 4% in the first year.
The value of the house depreciated by 2.5% in the second year.

Ibrar says,

"4 + 2.5 = 6.5 so in two years the value of my house depreciated by 6.5%"

(a) Is Ibrar right?
You must give a reason for your answer.

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the host asked how the grade descriptors will help to determine teachers' grading decisions:

- many teachers will **look closely at students' assessment results** over the students' time with them … some students have already done two 'mock' GCSE exams;
- teachers believe that **the grade descriptors will be particularly helpful when** they are making decisions about the grades of students whose **performance puts them near grade boundaries** … 'I'm trying to make sure the questions I ask will allow me to say 'well this shows …';
- teachers mentioned that 'some sort of ranking will allow for consistency across the **large cohorts** many of us have';

the host's final question was 'What will the next six weeks with your Y11/13 look like?':

- some **students will do three 'assessments'**, one a fortnight … 'it's going to be tense, though they seem to be holding up well';
- other teachers will provide **'revision and consolidation' lessons and a single 'assessment' in exam conditions**, 'with more class-based assessments if we need more evidence';
- in some schools **from mid-May, Y11 students will be grouped according to their future plans** … for example, teachers will 'have an A level maths group, a Core Maths group, a functional maths group, etc.';
- some teachers remarked that **'assessments in other subjects are impacting on us'** … if students have had an assessment in another subject earlier in the day 'they're a bit trigger happy' … some teachers are considering arranging for maths 'assessments' to happen during morning lessons only;
- at least one maths department is providing two 'assessments' a week with preparation for the 'assessments' in the remaining lessons …**'many students have now found that**

intrinsic motivation of knowing what they want/need out of the process … the majority are valuing the preparation sessions and using them well'.