Primary & Early Years Magazine 75

National Centre for Excellence in the Teaching of Mathematics

Welcome to another issue of our Primary Magazine. This magazine has been serving primary teachers for 74 issues with a varied collection of different articles related to maths education and mathematics professional development – all of which are accessible through the Primary Magazine Archive.

Contents

In each issue we have a selection of interesting and useful articles. New National Curriculum in Focus is dedicated to unpicking the new curriculum and how to understand and develop the requirements of the new programmes of study. This edition focuses on a new series of articles exploring how to design learning for column subtraction.

Where's the Maths in That? shares ideas for ensuring that mathematics is taught and experienced across the curriculum. In the coming months, this series of articles that will explore opportunities for mathematics and mathematical thinking within the new science programme of study. This month the theme is *Electricity* for Y4 and Y6.

Finally, Maths in the Staff Room provides simple plans for CPD meetings in your school to be led by a member of staff. These are short meetings that can be used exactly as indicated or adapted to meet the CPD needs of the school. We begin a series focusing in on the features of great teaching in the context of maths which was explored in full in. In this issue we explore Classroom Climate.

But first, we have a News section, bringing news from the NCETM and beyond to keep you up to date with the fast-changing world of mathematics education.

News

Mastery

The application window is now open for a new programme, run by the NCETM in conjunction with Maths Hubs, to train 140 primary teachers to become experts in teaching for mastery in mathematics. Participation in this high profile programme will require significant time input: twelve days' release from class duties in the first year, and around 30 days out of school in the second year. Applications close on **4 June**.

Teaching for mastery is the dominant theme in the first issue of a new, regular magazine from the NCETM. Bespoke is principally designed to bring news and information about the Maths Hubs programme, now approaching the end of its first year. The first issue has an in depth report from the recent Teaching Primary Maths for Mastery Forum in Birmingham, attended by around 300 primary school teachers.

If you want to see an example of what mastery teaching can achieve, then look at this problem that went viral in April, that is typical of the mathematical and logical thinking that grade 5 (Y6) pupils in Singapore are capable of solving. Good luck!

London Mathematical Society CPD Grants

Did you know that the London Mathematics Society (LMS) provides opportunities for schools/ teachers to bid for grants of up to £400 to support teachers with maths-specific CPD? There are certain conditions that need to be met and application deadlines for grants are 31 August, 30 November, 31 January and 30 April each year. These grants are available for all teachers.

NCETM National Curriculum support

Have you explored our National Curriculum Planning Tool yet? This interactive tool will support you in the following ways: your subject knowledge; making connections within and across the primary curriculum; suggest helpful papers, pupil activities, exemplification of expectations, and links to the suite of NCETM videos. There are also sections on the Bar Model, Teaching Fractions, Progression in Reasoning, and Developing a Scheme of Work - all accessible via buttons on the main National Curriculum information page.

Mathematics CPD

Don't forget that if you are looking for high quality providers of maths CPD in the next academic year, use our Professional Development Directory to find CPD Standard Holders (gold rosette) or Accredited Professional Development Leads (purple rosette).

New National Curriculum in Focus

New National Curriculum in Focus is dedicated to unpicking the new curriculum and how to understand and develop the requirements of the new programmes of study for mathematics. You can find previous features in this series here.

Designing learning for column subtraction

The new curriculum requires children to learn to use standard written methods sooner than has been taught in recent years. In their report Good practice in primary mathematics: evidence from 20 successful schools, Ofsted identified that in the most successful schools pupils were moved to standard written methods swiftly and once pupils were secure with interim methods were moved quickly on to more efficient methods.

What is important is that, if pupils are to be expected to move to a standard written method more quickly than previously expected, we need to ensure that that they do this not only with procedural fluency but with conceptual understanding.

So can this be achieved for the written method of subtraction?

Let's consider the Y4 statement from the programme of study:

> *…subtract numbers with up to three digits, using formal written method of columnar subtraction*

Before pupils can begin to learn to do this there are a number of skills and concepts that need to have been developed in order to carry out column subtraction with conceptual understanding:

- Visualise and understand how a four-digit number can be partitioned and recombined into multiples of 1000, 100, 10 and 1 with both concrete and abstract representations (i.e. base 10 [concrete], place value counters or arrow cards).
- Visualise the relative quantity of the numbers
- Know the value of a digit because of its position in a number
- Know that subtraction is not commutative
- Be able to say that a four-digit number is greater than a but less than b
- Be able to mentally and fluently subtract:
    - a three-digit number and ones
    - a three-digit number and tens
    - a three-digit number and hundreds.

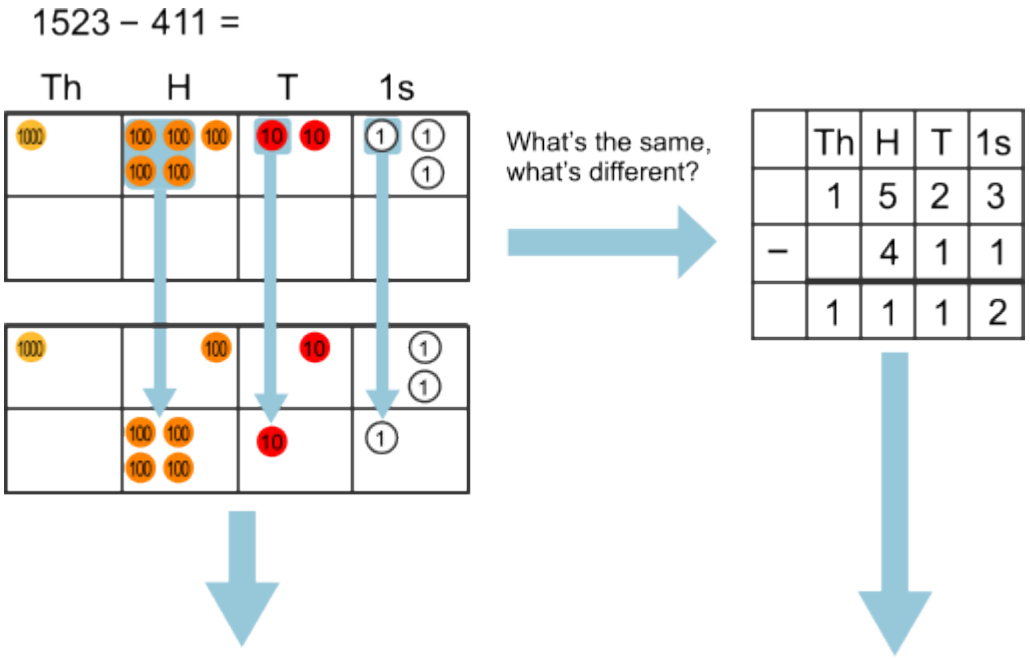
Scaffolding learning through procedural and conceptual variation

One particular feature of the teaching seen in Shanghai has been the use of teaching with conceptual and procedural variation. You can read in more detail what this means in the National Curriculum in Focus article in Issue 74.

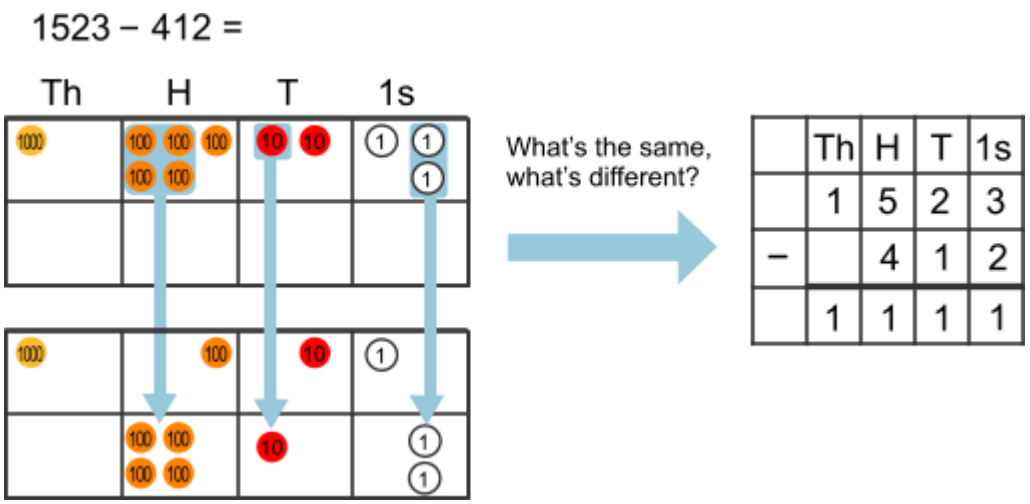
So what might conceptual and procedural variation look like in the context of teaching written subtraction of four-digit numbers? Written subtraction involves two distinct processes: subtracting without regrouping, and subtracting with regrouping. Consider a subtraction of the form ***a* – *b* = *c***. ***a*** is known as the *minuend*, ***b*** is the *subtrahend* and ***c*** is the *difference*. Regrouping occurs when, for example, a digit in the minuend is smaller than the digit in the corresponding place value position of the subtrahend. We begin without regrouping.

An assumption is made that the key skills and concepts mentioned above have all been acquired by the pupils working on this process.

Begin with a simple word problem. E.g. In a multi-storey car park there are 1523 parking spaces. 411 cars are parked. How many spaces are available? Write the word problem as an equation/ number sentence, demonstrate the written method using place value counters and use these representations to discuss the same and different features of this problem.



Vary the numbers slightly in the same word problem. In a multi-storey car park there are 1523 parking spaces. 412 cars are parked. How many spaces are available? Use this word problem as before to write the equation/ number sentence, demonstrate the written method with the place value counters and use these representations to focus on the similarities and differences of the representations for this new problem, the aspects that have stayed the same and have changed.



	Th	H	T	1s
	1	5	2	3
–		4	1	2
	1	1	1	1

The variations from left to right draw the pupils' attention to the meaning of the abstract representation which helps to reinforce the place value of the digits as well as providing an image for the vocabulary when a sentence such as "we subtract one ten from two tens".

The variation in successive steps helps to draw the pupils' attention to what changes when ones are subtracted.

This sequence could then continue with the pupils working with the teacher on a few further successions in the context of the same word problem. Such as, 1523 – 413 to observe the ones changing, followed by pupils practising with other similar numbers (without regrouping) in similar contexts, using the concrete resources, moving to different contexts.

Pupils could then work independently to deepen their understanding.

Which digits can you use to complete this column method?

	Th	H	T	1s
		2		
–			3	
	1			1

Or

Arrange the digits 0, 1, 1, 2, 3, 3, 5 in the column method to show how to get the answer 3121.

	Th	H	T	1s
–				
	3	1	2	1

A similar sequence in separate lessons might concentrate on subtracting 10s only, followed by subtracting 10s and 1s. Each without regrouping.

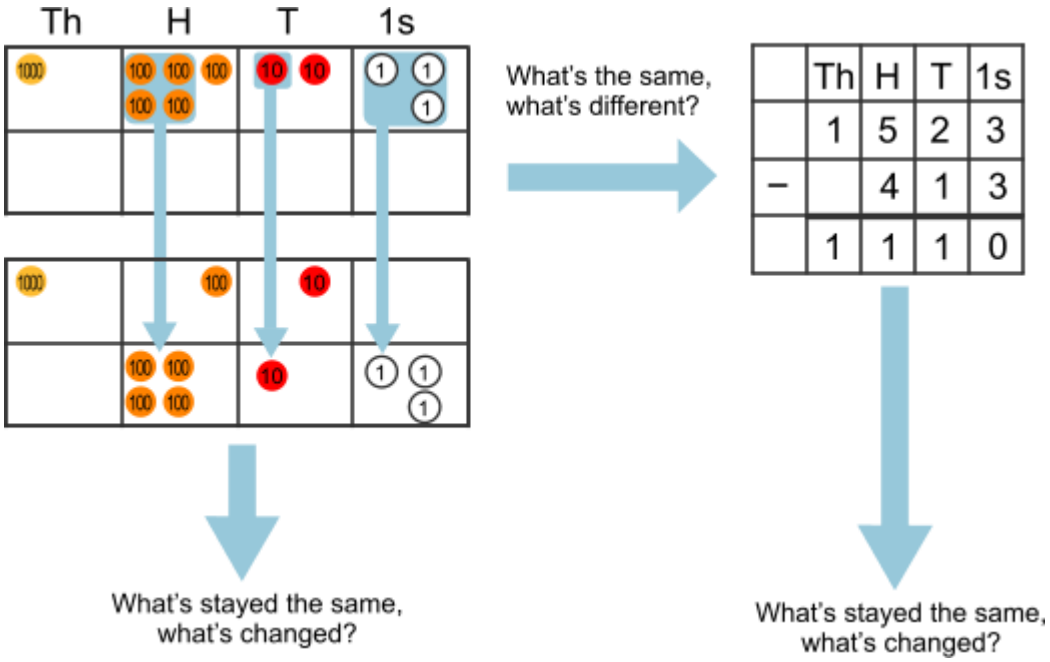
The examples above are also easily solvable by mental calculation and this could form part of the discussion towards the end of the lesson about how the children might now solve this problem in their head? Some pupils might refer to a number line, counting on or visualising the method taught above.

Subtraction with regrouping (or decomposition)

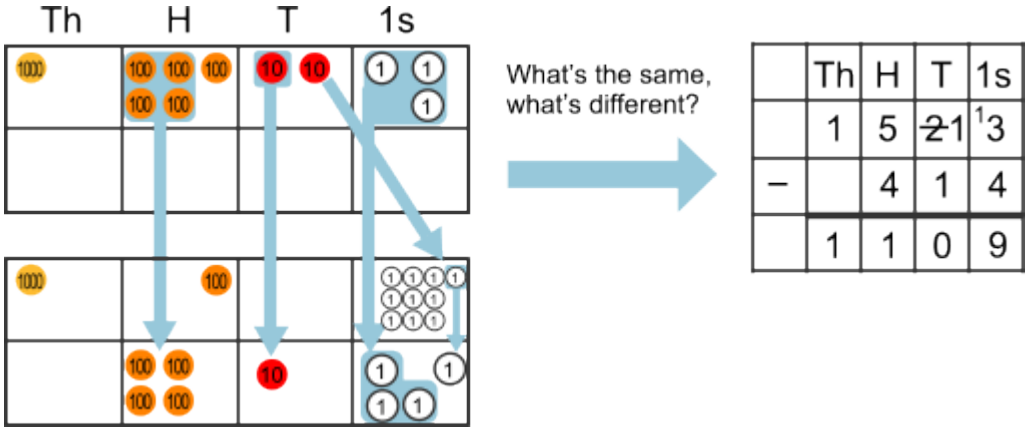
Use a familiar word problem. In a multi-storey car park there are 1523 parking spaces. 412 cars are parked. How many spaces are available? Continue to use this as the basis for the sequence of problems.

1523 - 412 =
1523 - 413 =
1523 - 414 =

This problem is what we might describe as the 'pivot point'. The sequence has been designed to provide some cognitive conflict as the procedure learned and understood thus far is now no longer effective. Ask the pupils to compare what's stayed the same and what's changed between the two successive problems. Similarly comparing the column method and how this is represented and has changed.



	Th	H	T	1s
	1	5	2	3
−		4	1	3
	1	1	1	0



	Th	H	T	1s
	1	5	~~2~~ 1	13
−		4	1	4
	1	1	0	9

The sequence might develop (using the place value counters) in the following way. What's the same and what's different? And 'What's stayed the same and what's changed?' will, as before, support the successive steps.

Working together with the teacher (in the context of the word problem)

1523 - 414
1523 - 415
1523 - 416

Working, supported by the teacher (in the context of the word problem)

1523 - 423 =
1523 - 424=
1524 - 424 =
1524 - 425 =
1524 - 426 =

Working independently

2535 - 535 =
2535 - 536 =
2535 - 537 =

Etc.

Using variation for regrouping will enable pupils to observe when regrouping of a 10 into 1s will need to happen. Sequencing the successive steps carefully will enable pupils draw a generalisation about the top (minuend) 1s digit being less than the bottom (subtrahend) 1s digit. A simple assessment task would be to ask pupils to sort problems according to whether regrouping was needed or not, without actually performing the calculation. Or asking pupils to consider ordering a set of subtraction problems according to their perception of difficulty, giving explanations.

Further resources:

- Primary Magazine Issue 59: Maths to Share - Subtraction.

Where's the Maths in That? – Maths across the curriculum

*In this section of this Primary Magazine we explore how mathematics can be embedded into other subjects in the context of the new curriculum. The subject in this new series is **science** and over the next few months we will explore the different themes for the KS1 and KS2 science programmes of study and how maths can be embedded in and enhance understanding of scientific ideas. You can find previous features in this series here.*

In this edition we look at the theme of **Electricity** for Y4 & Y6 and how a scheme of work for this might incorporate mathematical skills.

The statutory requirements are that children are taught to:

Y4

- identify common appliances that run on electricity
- construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers
- identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery
- recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit
- recognise some common conductors and insulators, and associate metals with being good conductors.

Y6

- associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit
- compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches
- use recognised symbols when representing a simple circuit in a diagram.

Suggested activities to use mathematics

- Discuss which appliances require mains electricity and which run on batteries; also which could use either, and construct a Venn diagram to show this.
- Sort materials that are conductors/ not conductors (i.e. insulators) against metal/ not metal on a Carroll diagram to help generalise about good conductors. Pupils should have the opportunity to experience that graphite in pencils conducts electricity but is not a metal and to place this correctly on the Carroll diagram.
- Investigate the brightness of a bulb as the circuit length varies. i.e. measure the length of the wire. Use a data logger to sense the light emission in lumens by using 1m tube to cover the bulb (to shield external light). Plot the data on a table and transfer to a graph. Observe whether the points plotted could be used to predict the light emitted with any length of wire.
- Design a decision tree/flow diagram for why an electrical circuit might not work.
- Investigate what happens to the brightness of a bulb or loudness of a buzzer as more components are added to a circuit. Use a data logger to provide accurate measurements to present on graphs.
- Electricity bills provide a wealth of opportunities to practise arithmetical skills. E.g. finding

the difference between meter readings to calculate consumption over a period of time, calculating cost of consumption, comparing consumption at different times of the year, looking at graphs that provide information about year on year consumption. This site provides useful information about what a bill contains.

- This electrical consumption calculator enables pupils to see how much electricity is used to run different common household devices. Pupils could survey the use of these pieces of equipment in their own home and then work out how much electricity is used to run them in a week, month and year. Pupils could also use the calculator to find out how much each appliance costs to run in a week, month and year.
- Pupils could design a consumption calculator in a spreadsheet by writing formula to work out the cost, usage per week, month and year.

Suggested links

- National STEM Centre eLibrary - Y4 Electricity
- National STEM Centre eLibrary - Y6 Electricity.

Maths in the Staff Room – Short Professional Development Meetings

This section provides suggestions and resources for a professional development meeting for teachers that can be led by the maths subject leader or another person with responsibility for developing mathematics teaching and learning in the school. You can find previous features in this series here.

Classroom Climate

In Issue 73 we provided a meeting to review the effectiveness of teaching mathematics in relation to the two recent reports on effective pedagogy and teaching:

- Exploring Effective Pedagogy in Primary Schools: Evidence from Research
- What Makes Great Teaching?

This meeting follows on from that first reflection and provides a more in depth understanding of how a group of teachers might address any areas of weakness from the audit carried out.

Meeting Aims

- Explore what an effective classroom climate means in the context of mathematics.

Timing

- 1 x 90 minute meeting
- 1 x 45 minute meeting.

Resources

- Teacher climate audit
- Pupil climate audit
- Video clip (The Growth MIndset)
- Video clip (Jaiman numbers)
- Video clip (Problem Solving and Building Confidence)(you will need to log in to the National STEM Centre eLibrary to download this)
- Climate data analysis spreadsheet.

The focus of these meetings will be to explore what classroom climate is and how teachers perceive their own classroom climate in the context of mathematics. The first session will be to explore a set of criteria for measuring climate based on research models and then to complete an audit. Discussing the outcomes. Teachers will then complete a pupil audit with a sample of children in each class. The results from both the teacher and pupil audit will provide the focus for discussion at the second staff meeting with an aim to find areas to work on both individually as a teacher and as a whole school.

Meeting 1

1.0 Share the aim of the session.

2.0 Ask the teachers to complete the teacher audit tool. The question styles are based around the tool used by Hay/McBer to audit classroom climate.

3.0 Provide the definition of Classroom Climate that was used in the Exploring Effective Pedagogy in Primary Schools: Evidence from Research:

> ***The classroom climate - the overall feeling in the classroom characterised by teacher-pupil and pupil-pupil relationships***
>
> *This was measured by observing the quality of pupil-teacher and pupil-pupil interactions. Children were well liked and respected by their peers. As well as good teacher-pupil relations, teachers supported their pupils' learning, they showed sensitivity and provided a safe environment. The quality of the relationships between teachers and their pupils was very important. Respect between teachers and children was a significant part of the classroom ethos and was evident in the observations of all the highly-rated classrooms. In these classrooms, children's opinions and feelings were valued and they were expected to respect the opinions and feelings of everyone in the classroom.* (p22)

2.1 Compare this to the definition in What makes great teaching?.

> ***Classroom climate/relationships/expectations***
>
> *Again, the empirically based frameworks all include something on classroom climate, though this heading may cover a range of aspects of teaching. Some (e.g. CLASS) emphasise the quality of relationships and interactions between teachers and students. Also under this heading may come teacher expectations: the need to create a classroom environment that is constantly demanding more and never satisfied, but still affirming to students' self-worth and not undermining their feelings of self-efficacy. Promotion of different kinds of motivational goals may also fit here, as may the different attributions teachers make and encourage for success and failure Related to this is the valuing and promotion of resilience to failure (grit).* (Sutton)

2.3 Reflect on these two paragraphs to ask teachers to create a list of key words that they think contribute to a positive classroom climate.

You might expect the following words to appear (amongst others)

A classroom where pupils are:

- Expected to achieve well
- Respected
- Valued
- Treated equally
- Taking risks
- Challenged
- Praised for effort
- Enjoying learning.

Discuss what this means specifically for mathematics.

- **Expected to achieve well** – teaching is aimed at the very least for age related expectations for mathematics

- **Respected** – pupils' different mathematical strategies are shared and considered as part of deepening and clarifying learning
- **Valued** – all pupils are given the opportunity contribute ideas through open questions, such as What do you notice? Etc.
- **Treated equally** – all pupils are provided with equal opportunity to learn the same mathematics
- **Taking risks** – all pupils feel empowered to have a go at any mathematics they are doing
- **Challenged** – all pupils' mathematical thinking is challenged through teacher and pupil questioning such as by asking how can you be sure?
- **Praised for effort** – pupils are encouraged and rewarded for making an effort rather than for 'ability' / giving right answers etc.
- **Enjoying learning** – pupils and teachers enjoy their mathematics lessons because activities are provided that are interesting and engaging for all.

The above list is very much the climate of classrooms where teaching for mastery is implemented.

Watch this video clip on Growth Mindset where Carol Dweck talks describes what this means for learners. Discuss what this means for mathematics classrooms? Refer to the work of Jo Boaler who provides an example of how a fixed or growth mindset is nurtured:

> *In mathematics, for example, if students are working on short, closed questions that have right or wrong answers, and they are frequently getting wrong answers, it is hard to maintain a view that high achievement is possible with effort. When tasks are more open, offering opportunities for learning, students can see the possibility of higher achievement and respond to these opportunities to improve.* (Boaler)

2.4 Watch this video clip and discuss the climate of this classroom in terms of the features already considered.

2.5 Watch a clip from 5:22 – 7:42 of this video and compare and contrast the climate to the first clip. Identify what Kate might work on to improve the climate.

2.6 Hand out the pupil cliamet audit and ask teachers to choose a sample of six from across their class to complete this (it may be best to draw names out of a hat). Older children might be able to do this independently. Younger children may need an 'impartial' adult to sit with them to complete the questionnaire.

Meeting 2

3.0 Use this spreadsheet to collate responses for each class. Enter the score (1,2,3, or 4) under the question number for the teacher's responses and also for each pupil. The spreadsheet will automatically calculate the average score for each question, rounding down to a whole number.

The difference figure will indicate the difference in perceptions between teacher and pupils. A difference of zero indicates that the teachers and pupils have similar views about this particular aspect of their classroom climate. A positive difference indicates that the teacher's perception is more frequent than the pupils. A negative difference indicates that the pupils' perception is more frequent than the teacher's.

3.1 Teachers should look at their data and identify any surprising differences and share this with the rest of the staff. Identify any common areas that show differences between perceptions and consider what

might be done to address these to ensure that teachers and pupils' perceptions are more harmonic rather discordant.

3.2 Consider how the teachers might discuss the finding of the questionnaire with their classes to develop further insight into the class climate.

Further support/ resources

- A Cross-National Investigation of Students' Perceptions of Mathematics Classroom Environment and Academic Efficacy in Secondary Schools (Dorman et al)
- Habits of Mind, an Organising Principle for Mathematics Curricula (Cuoco et al).