The Central Maths Hub

CASE STUDY

Closing the Gap

MathsHUBS Central

SCHOOLS INVOLVED

Tudor Grange Academy Solihull (Lead School)

World's End Junior School (Lead School)

St Augustine's Catholic High School

Bishop Challoner Catholic College

Castle Bromwich Junior School

John Henry Newman Catholic College

Mapledene Primary School

Parkfield Community School

St Peter's Catholic School

Studley High School

Tudor Grange Academy Redditch

AIMS OF THE WORK GROUP

1) To discuss strategies for preventing/closing the gap.

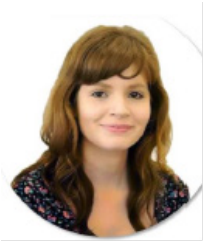
2) To identify 'best practice' within our schools currently.

3) To identify the key areas that need to be addressed to prevent gaps from occurring.

4) To identify subject specific pedagogies to support students with areas of difficulty.

Work Group Leadership

The Work Group was jointly led by the following colleagues:



Emma Penn

I have been the Curriculum Leader for Maths at Tudor Grange Academy in Solihull for two years. I am a Professional Development Accredited Lead with NCETM and I have a keen interest in collaborative work with other teachers, both within my academy and outside, to develop the teaching of mathematics. My schools will have the opportunity to observe these sessions during February and March at Colmore Infant and Junior Schools.

Claire Craddock

I am an Assistant Head Teacher and Maths Leader at World's End Junior School and an SLE with the Colmore TSA. I am a Professional Development Accredited Lead with NCETM and have a Post Graduate Diploma in Specialist Primary Maths. I am passionate about teaching and learning, particularly in mathematics and am leading the development of the 'World's End Centre of Excellence'.

The closing (or rather, preventing) the gap work group consisted of a number of experienced and talented primary and secondary mathematics teachers, who met regularly between December 2014 and April 2015 to discuss this broad area and the wider implications for mathematics teachers beyond the group. The Work Group was funded through the Central Maths Hub. Teachers in the work group collated:

1) **Strategies currently used to 'close the gap'.**
2) **Specific topics that differentiate between students who are becoming fluent and those who are falling behind.**
3) **Evidence of strategies to 'close the gap' through sample lessons and reflections.**

Evidence was collated through both face to face discussions and also clear gap tasks between sessions that focused on classroom research and developing subject pedagogy.

The key questions that the workgroup addressed were:

1) **How can we develop our practice (specifically teaching)?**
2) **How can the curriculum be modified?**
3) **What other practice can be developed?**
4) **Are there any specific mathematical topics that lead to gaps developing between different student groups?**
5) **Are there any methodologies from international best practice that we can draw on?**

The evidence gleaned from the Closing the Gap work group has been compiled within this report.

Work Group Activity

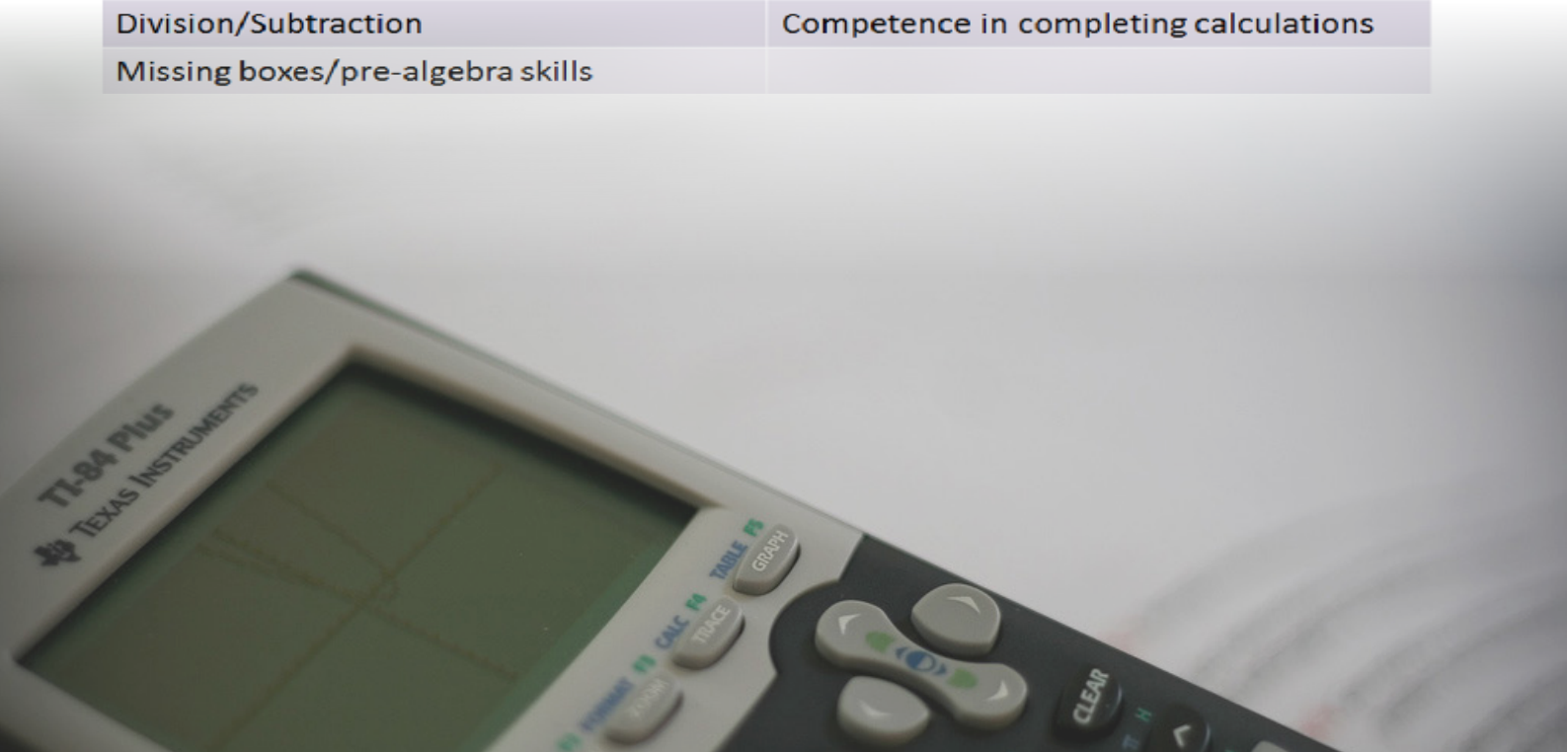
SESSION ONE

Initially, we collated our ideas regarding what is meant by 'the gap' and the strategies currently used to close 'the gap'. We found that typically, when we talk about 'the gap, it is with reference to key pupil groups such as Pupil Premium. The Work Group soon came to the realisation that it is much more than this. We found it helpful to consider 'the gap' as a gap in an individual's learning. Collectively there was acknowledgement that, if we can become more aware of where and when the gaps in learning emerge, we can strive to prevent them from appearing.

Challenges within the subject content:
We found that in all of our schools there were specific mathematical topics that led to gaps developing between different student groups and that these are similar. The table below summarises these findings

Table 1: Summary of common mathematical topics that may lead to gaps developing

Primary	Secondary
Number	Fractions
Place value	Multiplicative reasoning
Decimals/percentages/fractions	Ratio and proportion
Times tables/number facts	Time – linked to bases
Shape	Place value
Measures	Division – the purpose and the procedure
Conversions	Equivalence of representations – fractions, decimals, percentages
Time	Transition from number to algebra – the different roles that an unknown plays
Division/Subtraction	Competence in completing calculations
Missing boxes/pre-algebra skills	



FOCUS IS ON THE STUDENTS

The group also felt that when children struggled with particular mathematical skills, they were more likely to fall behind their peers. Broadly speaking these skills were:

- Fluency and accuracy of written calculations
- Use of mathematical vocabulary
- Justification and communication
- Geometrical reasoning
- Problem-solving (multi-step)
- Knowledge recall
- Mathematical (or otherwise) confidence
- Transferring of skills and making connections

There was much discussion about the possible reasons for this. In our experience we felt that:

- Children were being moved onto new concepts before they had mastered the previous one.
- Insufficient curriculum time was being given for topics to fully embed.
- Teachers still, very often, start a new topic from the beginning every time so that slow progress is made and students end up covering old ground.

OURS AND OTHERS' VIEW ON BEST PRACTICE

We also shared our understanding of what best practice in mathematics teaching looks like and studied articles on the mastery approach, international approaches and problem-solving.

The shared understanding of best practice in mathematics teaching that the group agreed include the following:

- High expectations of all children (including ASEND and low attainers).
- Pupils have a positive attitude to learning and demonstrate independence, enjoyment, confidence and resilience.
- Connections are made explicit between different areas of maths and real life.
- Real life connections are relevant and purposeful.
- Models and images are used to expose the 'structure' of the mathematics.
- Vocabulary is well modelled and visual.
- The pace is such that the children are engaged and on task.
- High quality, skilful questions throughout (Blooms).
- Teacher talk is kept to a minimum.
- The teacher rewards mathematical thinking rather than only correct answers.
- Formative Assessment is strong and teachers know previous and next steps and are able to adjust the learning accordingly.
- The learning journey ensures that all of the aims of the National Curriculum are threaded through

STRATEGIES CURRENTLY USED TO CLOSE THE GAP

The group shared examples of strategies that they currently use to 'close the gap'. When considering this, strategies fell into two key categories: those that take place outside of the maths lessons as an 'extra' support for the child and those that take place during lessons.

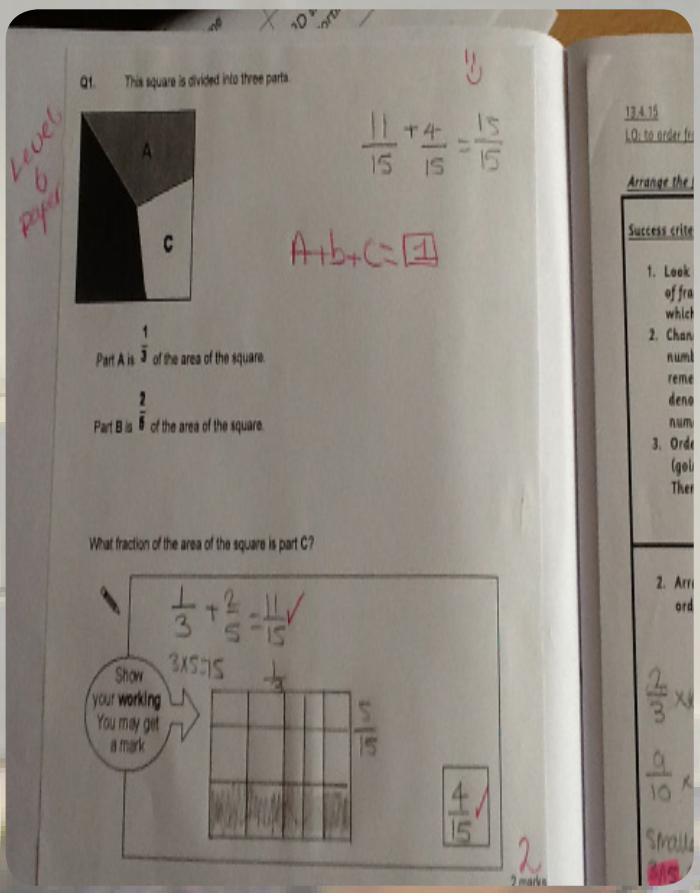
Strategies within the classroom:

- Teaching in smaller class sizes.
- Some schools use ability groups / other schools avoid ability grouping
- 'First and most' – targeting specific students for support, extra adults in the class.
- Whole school approaches to increasing fluency e.g. Big Maths, Rolling Numbers, numeracy challenges.
- Effective use of models and images (including ongoing teacher and teaching assistant training).
- Visual, well modelled vocabulary.
- Use of 'rich activities' - low threshold, high ceiling activities.
- Small chunks of teaching (2 week assessment cycle), with more time/lessons to reflect.
- Review, Reflect, Refocus – allowing lesson time to review work that has been done and act on identified areas to improve.
- Buddying up students.
- Assessing where students are at the start, use of prior knowledge and data to intervene.
- Pre-empting the misconceptions that some students will have and addressing these immediately, setting specific work to bridge gaps for some students.

Strategies beyond the classroom:

- Intervention resources e.g. Success@Arthmetic, 1st Class@Number, mathswatch, booster packs, booklets, GCSE pod videos and explanations.
- Rigorous CPD for teachers re subject knowledge and pedagogy.
- Learning to learn programs for staff and children – including pupil attitude surveys.
- Use of calculations policy.
- Use of pupil progress meetings.
- Use of diagnostic assessments.
- Cross curricular maths.
- Homework e.g. Mathletics, Mymaths.
- Work with parents e.g. workshops, selling resources.
- Clubs e.g. breakfast clubs, lunchtime clubs.
- Maths events and trips to raise aspirations.
- Extra time out of class – study supports, tutor time, enrichment lessons, maths tutor employed by school.
- Timetabling onto different routes where extra maths lessons are given.

FEEDBACK FROM PARTICIPANTS

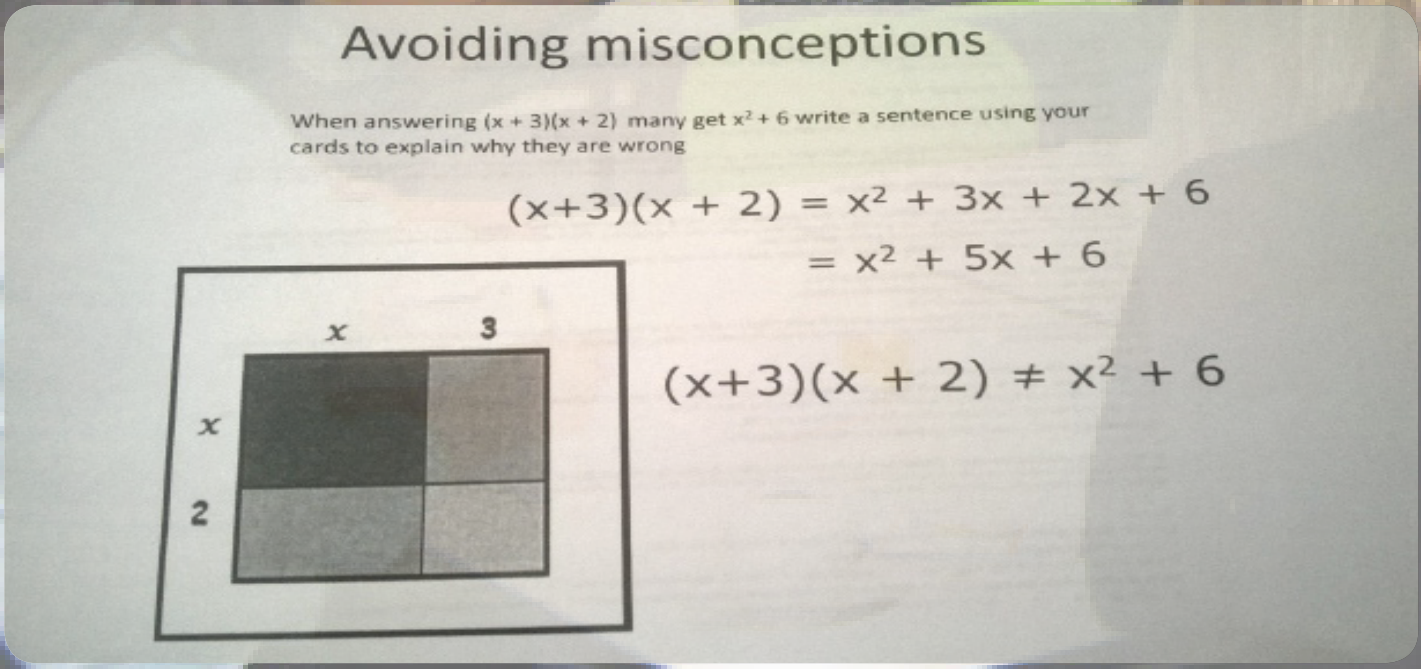


"I enjoyed looking into what 'the gap' actually is."

"I benefitted greatly from sharing ideas about best practice during the lessons to support quality first teaching."

"The opportunity for discussion of the gaps, current initiatives to close them and maths topics that appear to be most involved, was a positive experience as it meant that the group were able to think of and share practical tips."

"Having time to read some current articles and opportunities to reflect upon it benefitted me greatly."



THE GAP TASK

We felt that the next steps were to take what had been discussed and put it into practice. Therefore, as the gap task for session 1, participants planned and delivered a lesson on one of the key areas of maths identified, in such a way as to prevent or reduce gaps in understanding, whilst still ensuring challenge for all.

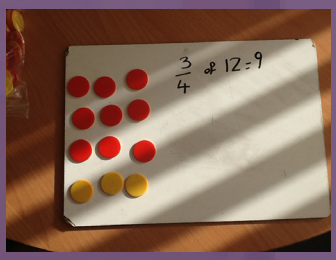
Work Group Activity

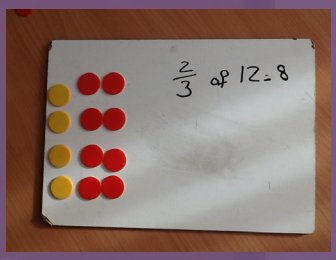
SESSION TWO

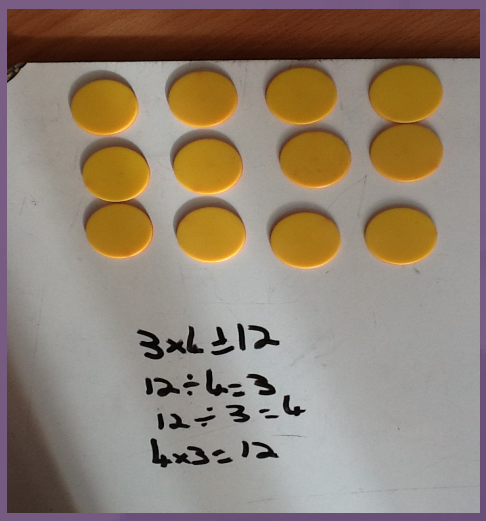
In the second session, we thought more deeply about how to address the issues identified with regards to best practice in mathematics teaching and the specific mathematical topics where gaps seem to emerge in students' understanding.

PRIMARY GAP TASK

This is an example of a gap task by a primary teacher. Some of the children were using the array to develop an understanding of the relationship between multiplication and division. Children who grasped this concept quickly took this further and were considering how the array found be used to represent fractions of numbers and the links with division.

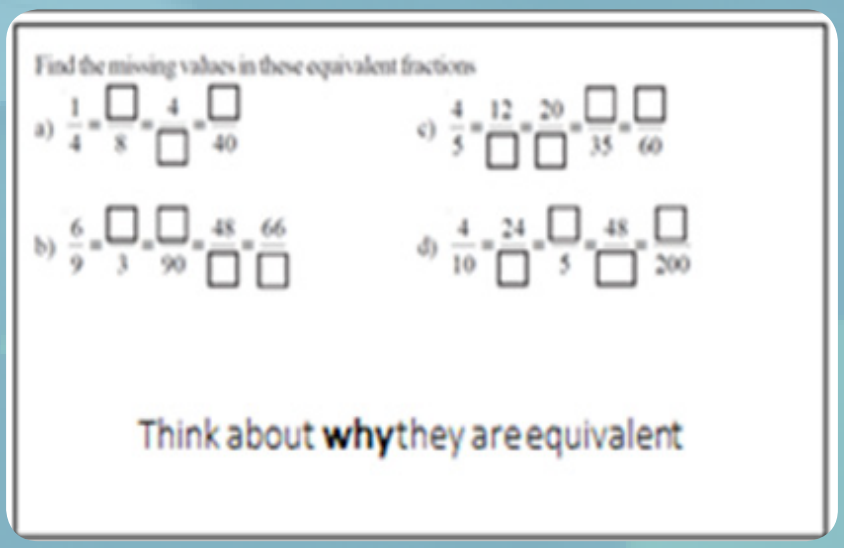






SECONDARY GAP TASK

This is an example of a secondary gap task lesson – focussing on the 'big' mathematical idea of equivalence and applying it in a variety of mathematical contexts, including simplifying fractions, calculations with decimals, and cancelling algebraic fractions. We felt that making links to a variety of different areas of mathematics through 'big' ideas and generalising could be one way to close the gap.



REFLECTIONS

We reviewed our discussions from last time in light of our gap task reflections and found the following aspects of particular interest:

- Frequency of revisiting topics is important. In particular, ensuring that they are not just add-ons (especially problem solving). Spaced practice can work well. For example using starters based on recent topics. But there is a difference between interleaving (linking topics together) and coming back to topics (spaced practice).

- With 'big' topics such as Ratio and Proportion, it could be the unpredictability of the varied applications of this topic that makes it more challenging for students. For example, we found that some students struggle to draw scales for graphs, whereas they can draw the actual graph if given the scale.

- In the secondary phase, are multiple representations used enough? Should we use more concrete and pictorial representations in the secondary phase to build abstract conceptual understanding, as this is how many topics are approached in the primary phase.

MASTERY CONFUSION

The gap tasks generated much discussion about what 'mastery' was. We found that there is much confusion over the term 'Mastery'. For example, the DfE Draft Performance Descriptors use the term to describe only the more able children who have achieved all of the objectives and need further challenge whilst the NCETM describe a 'mastery' curriculum of which all children will achieve. We came to the shared decision that the latter – the view of mastery as an ongoing approach to progression - was the definition that best fit what we are trying to achieve.

Teachers in this group view the new National Curriculum as a positive change. However, concerns were raised that some teachers are very negative about the National Curriculum due to the raised expectations. Therefore actions to raise the positive profile of the National Curriculum amongst teachers will be valuable.

THE GAP TASK

The gap task for session 2 was to research and trial an idea from a research document on one of the 'key areas' of mathematics in terms of closing the gap previously identified by the work group. We used the assessment strategies previously discussed to assess the impact. The research documents used can be found in the references at the end of this report.

Work Group Activity

SESSION THREE

During session 3, lesson ideas and research were shared and reflected upon. From the gap task work the group considered:

- Which research was used, how and why?
- Which area of mathematics was developed?
- What impact was seen and what had we learnt?

LESSONS FROM THE CLASSROOM

- Recapping prior knowledge, questioning and engagement in activities all support closing/ preventing the gap.
- Differentiation – does it widen the gap as different students are working on different activities? Or can it close the gap as it gives confidence to the lower ability? Allowing students to choose which questions they answer can support closing of the gap as students are working on what they feel that they need to and can see progression.
- Extension tasks can sometimes widen the gap if not used carefully. Within a lesson all students can be working on the same core concept, and to extend, the same core concept could be stuck to but other skills brought in.
- Does generalising close gaps?
- Breaking things down into small steps can close gaps.
- Students' understanding of what a mathematician is can be an important factor. For example, do children understand that writing working out down is important for a mathematician's communication?
- Identifying and addressing misconceptions is key for closing the gap.
- Proportional reasoning, equivalence and basic skills are key mathematical themes across the curriculum. If we can make links to these constantly, will this help to close and prevent gaps?
- Varying/cycling through how a question is framed can support the development of fluency
- Lesson study, with and without the use of video equipment, is an excellent way of developing best practice.
- One school are trialling mixed ability seating as they are developing a mastery approach. Could this close the gap?

FORMATIVE ASSESSMENT STRATEGIES

A key factor in closing the gap is identifying specific gaps in learning quickly in order to address any issues. Therefore time was spent sharing best practice on formative assessment.

These strategies listed below were being used by the group to reshape tasks during lessons, inform planning of the next lesson and to feed into future planning.

- Two part lessons: use the gap in between to adapt the next lesson according to formative assessment from the first part.
- Written marking: setting targets and closing the gap questions as gap tasks.
- Cycles of learning with 'Review Reflect Refocus' or 'Corrections Consolidation Challenge' processes.
- Questioning: to draw out misconceptions or reframe thinking.
- No hands up e.g. lollypop sticks.
- Self and peer assessment.
- Questioning, including 'show me' activities and open ended questioning
- Assessing depth of understanding via questioning. For example 'prove it', 'explain it'.

A NEED FOR PROFESSIONAL LEARNING

All agreed that none of these strategies could be effectively used if the teachers lack the subject knowledge to scaffold the learning or to know the next steps in challenging the children without accelerating learning into the year group above. High quality CPD for example Subject Knowledge Enhancement programmes are essential.

MORE ON MASTERY

Workgroup participants were very interested in the development of a mastery curriculum. This session included much discussion about the messages being given by various national bodies:

- DfE (Nick Gibb) – that the new National Curriculum is in line with that of countries which are high performing i.e. Shanghai and Singapore, and that they use a mastery approach.

- NCETM – Charlie Stripp stated that 'the new NC is a Mastery curriculum' and Debbie Morgan stated 'all children should master the curriculum and a few should go deeper' .

- OFSTED - Jane Jones, that mastery has been included in the training to the inspectors and that the inspectors are expecting the pace of lessons to be slower 'but it should be deeper'. Jones recommends that schools following this approach produce documentation for inspectors to clarify what they can expect to see in lessons.

The Work Group discussed the case study schools which had been highlighted at the Mastery for Primary Maths Conference at the ICC. The way in which the maths lessons are organised, how differentiation was not in content taught but age appropriate objectives scaffolded with models and images and also questions which ensure children go deeper, and how intervention is rapid and addresses misconceptions before the next lesson.

EFFECTIVE CPD

The final aspect we looked at was developing effective CPD in mathematics, particularly thinking about how we can ensure that the CPD has an impact on practice. Reference was made to research from NCETM. It was great to have cross-phase input (primary and secondary) and the opportunity to exchange ideas. These included:

- Facilitating collaborative work supports long term change, including doing mathematics together and sharing resources/ideas.
- CPD must take into account prioritised needs in order to be meaningful.
- Engagement is important (ownership, people buying into it, people actively doing things, evidence-based impact).
- Gap tasks between sessions motivate people to take prompt action and can encourage reflection upon the benefits.
- Should be long-term focused with long-term gains, not just focussed on short-term benefits
- Monitoring impact in order to provide support for those who require it is important.
- Providing opportunities for staff to reflect upon their current practice and new initiatives supports lasting change.

THE GAP TASK

The gap task for session 3 was to plan and deliver a CPD session in order to effectively disseminate one or more of our findings to date, with a particular emphasis on impact on practice.

- Monitoring impact in order to provide support for those who require it is important.
- Providing opportunities for staff to reflect upon their current practice and new initiatives supports lasting change.

Work Group Activity

SESSION FOUR

The gap task from session 3 was reviewed. Participants had undertaken some of the following activities in their school settings:

- Collation of a best practice booklet, containing a lesson idea from each member of the mathematics department
- Discussions about a mastery approach to teaching mathematics and planning for how this could be implemented
- Training of teaching assistants in primary schools to ensure that they were confident in the models and images used for teaching division
- Presentation of a training session about how feedback and formative assessment is used in lessons
- Analysis into basic skills and acceleration vs depth – and using this to make plans regarding future assessments

We then focussed on summarising the key findings and impact of the Work Group. This required a lot of reflection and discussion – something that we agreed teachers can always benefit from.

KEY FINDINGS

1). A focus on curriculum
Teachers must be aware of the topics which have greater potential for the emergence of gaps in mathematical learning and why, so that this can be prepared for and addressed.

2). Developing subject pedagogy
Energy and resources should be put into ensuring quality first teaching in lessons that prevents gaps in mathematical learning from occurring; rather than too much emphasis on interventions outside of the lessons to close gaps.

3). Making connections
'Big' mathematical ideas (ideas that span across several areas of mathematics and mathematical topics, for example, equivalence, proportion and multiple representations) need to be mastered. Teachers must be aware of these 'big ideas', their different applications and how they are connected.

4). Developing the concept through multiple representations
Teaching 'tricks' and rules without understanding is damaging as it hinders students' actual mathematical progress and therefore will lead to gaps later on. For example, teaching addition of fractions using the "kiss and smile" trick might help them to remember in the short term but in the medium to long term may cause confusion. Using representations which help the children understand the concept is far more likely to prevent gaps from emerging.

5). Rapid assessment
High quality formative assessment is key in identifying and addressing gaps in learning rapidly so that they don't have chance to widen. It also has a key place in assessing the depth of learning so that future gaps may be prevented.

6). Professional learning
All of the key findings link back to the need for teachers to have good subject knowledge and pedagogical knowledge and access to ongoing high quality CPD to continually develop these.

7). Understanding mastery
Teachers and students need to have a developed understanding of mastery. In particular, what it means to adopt a mastery approach, what mastery "looks like" in the classroom and crucially, how this might be assessed.

Impact on Teachers Involved in the Work Group

KNOWLEDGE AND UNDERSTANDING

- I have found out about mastery approaches – I hadn't heard of this until this Work Group – but my understanding of this has now improved.
- I understand the importance of Quality First Teaching.
- I know what is important for quality CPD sessions now.
- I have become more aware about what is important in the other phase – primary or secondary – and it has been great to be able to have more understanding of this and exchange ideas across the phases.
- I have learnt about how much research and tried and tested teaching methodologies there are out there that can be looked into.
- I have been able to learn from looking at examples that other participants have brought along to the sessions.
- It is great to hear about what is happening in other schools and learn about the impact of these things.
- I am now more aware of which topics have the potential of causing attainment gaps in mathematics.

ATTITUDES, DISPOSITIONS AND BELIEFS

- "I believe more in the importance of Quality First Teaching – rather than waiting until later to intervene to close gaps, we can actually work harder to prevent gaps from emerging in the classroom!".
- "My attitude towards mixed-ability teaching has changed; I now believe that this could be a really powerful strategy for preventing gaps".

- I feel now that it is more important to embed understanding before moving on to the next thing.
- I believe now that some of the ideas we have explored not only prevent/close gaps in attainment, but overall provide a better mathematics education and learning experience for students.
- I have been reassured about what the priorities are in this uncertain period of change.
- I believe that students' understanding is key and this Work Group has given me the confidence to challenge practices where this might not be the underlying belief.
- I want to ensure that 'big ideas' in mathematics are mastered at my school!
- I feel it is important that students understand the reasoning and purpose behind mathematical topics, rather than just being told "this is how it's done".
- I believe that multiple representations are key in mathematics teaching.
- It is important to have the opportunity and space to reflect on your own teaching through projects like this.

TEACHING AND LEADERSHIP PRACTICE

- I have a greater confidence in my ability to deliver high quality CPD to others.
- I have embedded new approaches in my teaching – such as trialling new assessment strategies – and I have tried some of the practice we have discussed here in my own school.
- I have put these ideas forward in my own school for use in the making of a new scheme of work ready for the new GCSE.
- I am using more concrete and visual representations in my lessons, and others in my mathematics department are too.
- I am going to try my teaching being less teacher-led and more investigative, so that students become more resilient and better at solving problems.
- I am going to continue to work with other schools as I have experienced that you can learn a lot from having links and sharing outstanding practice.
- By being involved with this Work Group, I have been made to actually do something and try ideas out – this is a good thing!
- We are going to look at the curriculum structure at our school to implement the findings from this work group.

Implications for the Wider Mathematical Community

The outcomes from this Work Group highlight many implications for the wider mathematical community. Despite the challenges associated with implementing the new National Curriculum, it provides a fantastic opportunity for us to reflect on our teaching and rethink our approach. Schools and colleges need to be giving careful consideration to the structure of their own curriculum in mathematics including thinking carefully about the amount of content being covered and when to move on. As always, high quality, rapid assessment is critical and purposeful practice forms an important part of this. Mastery is clearly still an issue that schools and colleges are grappling with and more time needs to be given for professionals to meet and discuss this key area. To facilitate all of this there needs to be opportunities to engage in professional learning. If we are to prevent gaps from occurring then more of the same is not what is needed.

WHERE NEXT?

Members of the closing the gap Work Group are keen to further explore some aspects of the work they have already started. The group will continue to meet to look at

- Teaching through big mathematical ideas.
- Mixed-ability mathematics teaching and the mastery approach.
- Growth mindset and metacognition.
- Curriculum design.

If you would like to be part of this workgroup then please contact us via

mathshub@bishopchalloner.bham.sch.uk

Further Reading

Links to articles and research documents that might be of interest to other professionals.

- Burghes, D. and Robinson, D. (2010) Lesson Study – Enhancing Mathematics Teaching and Learning.
- Central Maths Hub, 2015. Shanghai Special.
- Education Endowment Foundation, 2014. Sutton Trust – EEF Teaching and Learning Toolkit. Accessed from: http://educationendowmentfoundation.org.uk/toolkit/
- Jane Jones Guest Blog. Accessed from: https://www.ncetm.org.uk/resources/46034
- Linsell, C., Tozer, L. and Anakin, M. (2012). Teaching algebra conceptually in Years 9 and 10. Accessed from: https://blogs.otago.ac.nz/tac/
- National Centre for Excellence in the Teaching of Mathematics, 2009. Researching Effective CPD in Mathematics Education. Exploring effective professional development for mathematics teachers.
- National Centre for Excellence in the Teaching of Mathematics, 2014. Mastery approaches to mathematics and the new national curriculum.
- National Centre for Excellence in the Teaching of Mathematics, 2014. Shanghai Teachers: mid exchange report.
- Nunes, T. and Bryant, P. (2009) Understanding rational numbers and intensive quantities. Nuffield Foundation - Key Understandings in Mathematics Learning.
- Nunes, T., Bryant, P., Watson, A. (2009) Introduction and summary of findings. Nuffield Foundation - Key Understandings in Mathematics Learning.
- OFSTED Framework for School Inspection and School Inspection Handbook
- Smith, C. (Ed.) (2011) Fractions in context: the use of ratio tables to develop understanding of fractions in two different school systems. Proceedings of the British Society for Research into Learning Mathematics, 31 (3): 23-28
- Teaching and Learning Research Programme, 2006. Fractions: difficult but crucial in mathematics learning. Teaching and Learning Research Briefing. Accessed from: http://www.edstud.ox.ac.uk/research/childlearning/index.html
- Welder, R. (2012) Improving algebra preparation: implications from research on student misconceptions and difficulties. School Science and Mathematics, 112 (4): 255-264
- Williams, J. (Ed.) (2003) Errors and Misconceptions in KS3 'Number'. Proceedings of the British Society for Research into Learning Mathematics, 23 (3): 7-12