

Investigating How the East Midlands Mathematics Hubs Support Teachers' Practice

East
meets
West



Andrew Clapham, Peter Gates and Rob Vickers

East meets West

Research Report

January 2017

The authors of this report would like to thank the many teaching professionals who have so generously given their time, support and enthusiasm to assist with this evaluation.

The views expressed in this report are those of the authors obtained through systematic research and do not necessarily reflect those of the East Midlands East Mathematics Hub, East Midlands West Mathematics Hub, the University of Nottingham or Nottingham Trent University

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Published by Centre for Research in Mathematics Education, University of Nottingham.

Funded by East Midlands East and East Midlands West Mathematics Hubs.

East meets West

Reflecting on Mathematics Mastery:

'I think impact on practice has been absolutely huge.' – Primary maths lead

'It has kind of reignited my passion for maths, plus I can see how it is having really positive implications for my year one.' – Year one teacher

'I do feel it has completely changed my attitude to maths, it's made me do my research a bit more and it's enthused me.' – Year one teacher

'If Schools don't engage, if schools don't keep learning practice can't develop.' – Primary school head teacher

'But it was that Mastery, that deeper level of thinking, that higher problem solving where we really saw the results.' – Primary school deputy head

'Everybody is doing the thinking together; everybody is doing the learning together, then they all move together.' – Year one teacher

'We just want to deliver maths the best we can.' – Primary school principal

'Everybody is doing the thinking together; everybody is doing the learning together, then they all move together.' – Year one teacher

'So to me Mastery is that really deep understanding and making connections to learning.' – Year one teacher

'Actually Mastery in maths is about us all being able to master something.' – Primary School head teacher

'It has been shown to work in Singapore, it has been shown to work in Shanghai and it does work, it just takes a little bit of time.' – Primary maths specialist

'For me Mastery teaching is about that depth of knowledge.' – Primary head teacher

Executive Summary

This report explores how the two East Midlands Mathematics Hubs are mediating teachers' work and understandings of mathematics and mathematics education. To do so it asked the following primary research question: *'How do the East Midlands Mathematics Hubs support teachers to develop the learning of mathematics through the two national priority projects - Singapore Textbook and Shanghai Teacher Exchange'*.

Singapore Textbooks

- Feedback from the practitioners who took part indicates that the first year of the Maths textbook trials was successfully introduced and implemented.
- Participants' overall assessments of the CPD opportunities which they received as part of the trial were very positive.
- Practitioners have stressed the importance of adequate Continuing Professional Development (CPD) and being properly prepared in order for the Singapore style textbooks to be used effectively within the classroom.
- The evidence indicates that it is particularly valuable for training or induction programmes to provide practical illustrations of the way the textbooks can to be used within the classroom setting.
- Contributors have commented that the textbook project has helped to add to the expertise in teaching mathematics, in participating schools. In particular, it has been highly effective in generating enthusiasm amongst professionals, motivating teachers to think about and enhance their understanding of mathematics education.
- The practitioners that participated in this research were not able to articulate a coherent set of principles and beliefs which they felt were important components of a Mastery approach.
- Perhaps most significantly, participants strongly advocated the idea that all children can master the curriculum but how this was to be achieved was less clear.
- An additional element of Mastery, which all participants emphasized, was the centrality of enabling every

pupil in their class to acquire a deep understanding of the mathematics they were learning.

- Having a well thought out approach to presenting all pupils with central mathematical concepts, and illustrating the connections between them, was seen as one of the principal merits of using the textbooks.
- Many of the practitioners who have taken part in the trial mentioned that there are some challenges relating to classroom management when using the textbooks, especially with younger children. In particular, juggling multiple resources and having mixed-aged year groups.
- Participants have stressed the need for ongoing assessment as an integral part of teaching, in order to constantly check pupils' understanding of what they were learning. By doing so contributors felt they were able to monitor that the children were making the desired progress.
- By continually assessing pupils' progress teachers suggested they

were able to intervene swiftly to address misconceptions. It also presented the opportunity to adapt teaching and learning activities to reinforce student attainment.

- It would appear that there is a feeling that the textbooks can help to develop a Mastery approach to mathematics. However, there is a danger they are being injected into a procedural culture already established and embedded in classroom rather than incorporating the culture that would be normal and unquestioned in Singapore.
- Evidence suggests using the Singapore style textbooks are not having a significant impact upon the lowest performing mathematicians.

Shanghai Teacher Exchange

- Feedback from participants has been very positive regarding the way the England – China teacher exchange was carried out, both during and after exchange phase of the visit.
- Participating schools have said that they encouraged all teaching staff

at their institutions to observe at least one session delivered by teachers from Shanghai. They also welcomed colleagues from other schools across their regions to see the Shanghai approach.

- Professionals have engaged with the project in a variety of ways, while the level of involvement has varied, it has helped to foster and promote some exploration and development work that is still resonating within a number of schools.
- Interviews and consultations with a range of professionals, from across the Maths Hub regions, indicate that many of them have taken advantage of the opportunity to observe the Shanghai approach to mathematics education. Many said they have been able to incorporate some elements of what they observed within their own classrooms.
- As well as transmitting information about the Shanghai approach, the trial has also helped to encourage teachers to increase collaboration

to enhance their delivery of mathematics teaching.

- The features of the Shanghai style of mathematics teaching, most commonly cited by professionals were:
 - Greater depth
 - Longer time devoted to topics
 - Whole class working together
- There is evidence to suggest the structure and approach used to organise the initial teacher exchange projects was an effective means of letting practitioners see a different approach to teaching mathematics. This has helped to spread some philosophical viewpoints behind teaching for Mastery, and encouraged professionals to investigate good practice in mathematics and the differences these can make.
- As more professionals develop an understanding of a Mastery approach and it begins to become embedded in classroom practice, so there may be the need to change the ambition behind future exchange visits. Rather than having a general aim of exposing

practitioners to a different mathematical culture, they should instead focus on specific areas of practice which is in need of development.

Math Hubs Impact

- Contributors have suggested the Singapore Textbook and Shanghai Teacher Exchange projects have been an effective means of transmitting information about a Mastery approach. Both internally within the institutions taking part and externally to other schools within the region.
- Via the national projects the Hubs are supporting teaching for Mastery, by helping teachers to investigate good practice in mathematics and the differences these make.
- Our research evidence indicates the practitioners involved are not necessarily following either of the projects, rather they are trying to understand which aspects are most helpful, and evaluating how this can best develop practice. The emphasis has very much been on professionals trying to understand

what works best within their own classrooms.

- The practitioners who took part in this evaluation revealed that they are not restricting themselves to a single source of information about Mastery. Rather the Maths Hubs are assisting them in receiving information from multiple sources.
- The national projects are just one of the ways in which the Maths Hubs are influencing the development of practice in mathematics teaching and learning. Participants have also made reference to accessing multiple services they provide for a variety of information and practical support.
- Those practitioners who were consulted agreed that the sharing of experience in the way promoted by the national projects is valuable. They suggested that they would appreciate the opportunity to have more official meetings supported by the Maths Hubs to share ideas and findings relative to effective practice.

- Participants have said that Mastery is not a ‘quick fix’, rather it requires time. Not only for pupils to develop a deep rather than superficial conceptual understanding, but also for the schools and teachers delivering a Mastery curriculum to ensure consistency of provision in all classes. Therefore, ongoing support for teachers and school leaders is essential if the approach is to become established.
- Schools within the East Midlands report they have made changes to practice, which they suggest are having a positive impact upon pupils. In particular, teachers who took part in the national projects have said that their pupils are now enjoying and engaging with mathematics more.

Conclusion

A Mastery pedagogy is a new way of working for the majority of English primary schools (Townsend, 2015), meaning it is advantageous to support teachers to make this transition. There is a body of evidence to indicate that via the national projects the East Midlands Maths Hubs have aided a number of practitioners to gain an

understanding of the essential ideas behind mastery – that all children need a deep understanding of the mathematics they are learning (Askew et al, 2015).

However, there was also some degree of intangibility over the nature of “mastery” and what that might mean in practice. This is also an issue nationally

Although the national projects have helped to disseminate information about effective practice, some professionals have commented that it is not always straightforward implementing the changes which they would like to in school. This seems to be especially true when teaching older cohorts who have not previously had experience of a Mastery approach.

The implication is clear; it is important to start teaching for Mastery at an early stage of pupils’ school careers before gaps in attainment emerge. The ongoing work of the Maths Hubs will be an important aspect of embedding this across the region.

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Investigating how the two East Midlands Mathematics Hubs support teachers' practice

1. Introduction

In this report we explore how the two East Midlands Mathematics Hubs are mediating teachers' work and understandings of mathematics and mathematics education. To do so we explored the following primary research question: *'How do the East Midlands Mathematics Hubs support teachers to develop the learning of mathematics through the two national priority projects - Singapore Textbook and Shanghai Teacher Exchange'.*

The question relates to a range of different elements that support mathematics teachers' practice including:

- 1) the mathematical culture in schools and classrooms;
- 2) teachers' pedagogical content knowledge and
- 3) teachers' understanding and implementation of didactics.

In tackling these questions, we have developed an understanding of the work of the Mathematics Hubs in the East Midlands. Furthermore, we examined in particular, how mathematics teaching originally located in Singapore and Shanghai has translated to an English context.

1.2 Maths Hubs and the National Projects

1.2.1 Motivation behind the Maths Hubs

The Maths Hubs programme is funded by the Department for Education (DfE) and coordinated centrally by the National Centre for Excellence in the Teaching of Mathematics (NCETM). In July 2014 the DfE announced that the national network of Maths Hubs will seek to match the standards achieved in top-performing East Asian countries. The 35 Hubs across England are led locally by an outstanding school or college in each area. The intention is to

provide a model for schools in implementing “*the Asian-style mastery approach to maths which has achieved world-leading success*”¹.

The Programme for International Student Assessment (PISA) has the objective of producing cross-nationally comparable information on children’s abilities in math. In the PISA 2012 mathematics assessment league table Shanghai was ranked top, Singapore second and Hong Kong third, the UK was in 26th place overall (OECD, 2014). Jerrim and Choi (2014: 17) assert that “*there is a large gap in math achievement between England and leading East Asian nations even at age 10*”. The PISA 2012 survey suggests that by age 15 pupils from high performing jurisdictions, particularly those of east and south-east Asian countries such as China, Singapore, Japan and South Korea, are on average up to three years ahead in mathematics compared to 15-year-old pupils in England (PISA, 2014). Interestingly, as pointed out by Frederick Leung an expert in Mathematics Education from Hong Kong (Leung, 2001; Leung et al., 2006), all those countries heading the PISA table use an ideographic form of writing suggesting the causes of international differences should not simply be attributed to schools, teachers or pedagogy. Compared to a number of countries, the UK has a bigger gap between the highest and lowest attaining students in mathematics – associated most strongly with pupil socio-economic status. Within high performing countries, where a Mastery approach can be described as established, disadvantaged pupils do on average as well as their peers (PISA, 2014), however pupil differences in both social background and attainment, form a central part of the organizational principles of mathematics education in the UK through setting and ability grouping.

The Department for Education (2012) conducted a review of the mathematics syllabus in a number of East Asian countries to inform the 2014 update of the curriculum in England. The new curriculum encourages depth and breadth of mastering content, rather than accelerating through yearly learning objectives (Askew *et al*, 2015: 4). The National Curriculum states:

The expectation is that the majority of pupils will move through the programmes of study at broadly the same pace. However, decisions about when to progress should always be based on the security of pupils’ understanding and their readiness to progress to the next stage. Pupils who grasp concepts rapidly should be challenged

¹ <https://www.gov.uk/government/news/network-of-32-maths-hubs-across-england-aims-to-raise-standards>

through being offered rich and sophisticated problems before any acceleration through new content. Those who are not sufficiently fluent with earlier material should consolidate their understanding, including through additional practice, before moving on.

(National Curriculum in England, July 2014²)

As well as influencing the content of the National Curriculum, the way that mathematics is taught in high performing education systems was also looked at. Consequently, a Mastery approach was made central to the curriculum (DfE, 2013: 99). Elizabeth Truss (2014) stated:

We must learn from the systematic practice of these high achieving countries, who are constantly seeking to improve. Maths Hubs will bring this approach to all parts of the country and all schools will be able to benefit.

(Elizabeth Truss, Under Secretary of State for Education in England)

Such a strategy of course fails to recognize the multidimensional nature of pupil achievement as cultural, linguistic as well as pedagogical.

1.2.2 The mathematics Mastery approach

NCETM (2014) has acknowledged that whilst there are many differences between the education systems of England and those of east and south-east Asia, we can learn from the 'Mastery' approach to teaching commonly followed in these countries. NCETM identify certain principles and features that characterise this approach:

- Teachers reinforce an expectation that all pupils are capable of achieving high standards in mathematics.
- The large majority of pupils progress through the curriculum content at the same pace. Differentiation is achieved by emphasising deep knowledge and through individual support and intervention.
- Teaching is underpinned by methodical curriculum design and supported by carefully crafted lessons and resources to foster deep conceptual and procedural knowledge.
- Practice and consolidation play a central role. Carefully designed variation within this builds fluency and understanding of underlying mathematical concepts in tandem.

² <https://www.gov.uk/government/publications/national-curriculum-in-england-mathematics-programmes-of-study/national-curriculum-in-england-mathematics-programmes-of-study>

- Teachers use precise questioning in class to test conceptual and procedural knowledge, and assess pupils regularly to identify those requiring intervention so that all pupils keep up.

(NCETM, 2014)

These points were reiterated by Debbie Morgan, NCETM's Director for Primary, in relation to the Maths Hubs and National Projects³. Morgan has suggested that the essentials of Mastery include:

- Deep and Sustainable Learning
- The ability to reason about a concept and make connections
- The ability to build on something that has already been mastered
- Conceptual and procedural fluency

Academic writers have produced a similar set of features attributed to helping children master mathematics, including:

- An emphasis on high expectations and a growth mind-set (Boaler 2010);
- Understanding is more likely to lead to high quality outcomes than memorising (Dahlin and Watkins, 2000);
- The use of objects and pictures to represent mathematical concepts (Sowell 1989);
- A systematic approach to mathematical language (Hoyles 1985).

However, there is very little research evidence underpinning the current approach known as "Mastery" which challenges claims to value evidence-based practice.

1.2.3 National projects

The Maths Hubs are undertaking a number of complementary projects, with all hubs working in a common way to address a programme priority area. Central to these have been the national projects:

- (A) Textbooks and Professional Development project, which has involved primary schools using adapted versions of textbooks currently used in Singapore. This is backed up by

³ http://www.george-spencer.notts.sch.uk/images/itl_demo/doc/Maths%20Hub/Maths%20Hubs%20&%20National%20Projects.pdf

professional development activities, as a means of supporting teachers to implement the Mastery approach.

- (B) England – China teacher exchange, enabling exchanges of teachers between schools in Maths Hub areas and schools in Shanghai. The project has the objective of exploring the implementation of teaching for mastery approaches in maths lessons in English schools.

1.2.4 Singapore textbooks

The textbooks project began in January 2015, and has involved at least two primary schools from each Maths Hub region trialling the use of adapted versions of textbooks currently used in Singapore in their Year one classes. The Department for Education and NCETM have selected two texts, which the participating schools have chosen between: **Inspire Maths**, (Published by Oxford University Press) and **Maths – No Problem**, (Published by Maths No Problem). Both texts have been adapted in line with the new UK National Curriculum.

The teachers who were involved in the trial took part in centrally provided Continuing Professional Development (CPD) prior to using the textbook in their classrooms. Additional workshops took place while the project was underway to further enhance their work with the textbooks. The training was designed to support them in:

- introducing the books to pupils;
- using the books in the course of lesson planning and design;
- their own professional learning⁴.

In terms of professional learning, the intended outcomes for the project are to deepen participating teachers' specialist subject knowledge of teaching Year one mathematics and understanding of Mastery pedagogy. While the leadership within the primary schools have been assisted to understand of the needs of teachers in order to support the effective use of the textbooks.

⁴ <http://www.mathshubs.org.uk/find-your-hub/east-midlands-west-maths-hub/>

1.2.5 England – China project

Charlie Stripp, NCETM's Director, has suggested that a major element of the leadership and development of Mastery teaching is through the DfE-funded England-China Mathematics Education Innovation Research Project. Saying that:

The project will help us to develop how we use the Mastery approach to maths teaching in our primary schools, to improve maths education and the mathematical futures of our young people. It also provides a brilliant opportunity to develop close working relationships between the English and Chinese teachers involved, so that they can learn from each other, to the benefit of teachers and children in both England and Shanghai⁵.

(Stripp, 2014)

Across England twenty-two Wave 1 schools hosted Shanghai exchange teachers between the 3rd to the 28th November 2014 and 26 wave 2 schools hosted from 23rd of February until 20th March 2015. The language used for teaching was English, with the year groups involved varying from school to school. For the majority of the time, the visiting Chinese teachers' lessons were observed by their partner teacher from the English school, other colleagues from the same school, and frequently by groups of teachers from other local schools.

⁵ <https://www.ncetm.org.uk/resources/45776>

2. Evaluation Methodology

This analysis consists of a series of case studies which focus upon the East Midlands primary schools and teachers who have been supported by the corresponding Mathematics Hubs to participate in the two national projects. Interviews with a range of teachers and school leaders and observations of teaching has generated the qualitative data presented here.

2.1. Strand 1 – Textbooks and Professional Development Project

This strand focused on schools where the Singapore textbooks were being used with these schools forming case studies. This strand looked at both textbook series: Maths - No Problem and Inspire Maths. Since, a significant part of the project is the accompanying CPD, this has also formed part of the evaluation.

The schools were visited, with teachers and Head teachers being interviewed. Lessons in which the textbooks form the basis of the lesson were observed and analysed from the perspective of the use of the textbook in informing change in the teacher's didactical and pedagogical approaches.

2.1.2 Evaluation instruments

This strand has drawn on the following data:

- *Interview schedule for class teachers*
Ways of using textbooks, pupil responses, attitudes to content and to pedagogical strategies, interpretation of tasks, presentation of work, use of supplementary resources, definitions of “mastery”, level of teachers’ own mathematics, manageability of textbooks, marking and feedback on pupil work, what changes in practice, experiences and impact of training.
- *Interview schedule for head teachers*
Reasons for engagement in project, choice of classes and teachers, policy implications, cost implications, school procedures and training, sustainability.
- *Lesson observation schedule*
How mastery is interpreted, setting up of tasks, use of materials, whole-class/group work, pupil differentiation and “staying together”, mastery, use of Teaching Assistants.
- *Impact*
Measurement of pupil progress, whole school dissemination strategy, parental engagement, impact on other teachers, influence on other schools.

2.2 Strand 2 – England – China Teacher Exchange

This strand used a methodology similar to that used in Strand 1. That is, central has been the collection and analysis of rich case study data arising from schools that have taken part in the Shanghai Teacher exchange within the geographical area served by the East Midlands Hubs. Important in this regard has been those teachers who directly took part in the exchange. However, it was important to explore the cascading of any information and learning through each of the participating schools. Teachers have been interviewed and changes in their practice resulting from their experiences as a participant in the project identified. Case studies have identified the impact this has had at a school level. Schools which are participating in the Shanghai teacher exchange have been visited and a range of stakeholders including teachers, head teachers and teaching assistants interviewed to identify how the exchange has impacted on mathematics teaching in the schools. Semi-structured interviews and observations have been used to generate data. Wider impact has been identified by considering how this project has connected with teachers in other schools.

2.2.1 Evaluation instruments

The following data was collected in this strand:

- *Interview schedule for lead teachers*
 - Experience of visit to Shanghai: what they learnt about culture/context, pedagogy, didactics;
 - experience of Shanghai teacher to their school: what they learnt about culture/context, pedagogy, didactics;
 - what has been adopted / adapted as a result of exchange;
 - future plans, support needs;
 - what has been shared, in-school, beyond school, specifically across hub, more widely;
 - the mastery agenda and how this is being interpreted and implemented.
- *Interview schedule for all other teachers and teaching assistants*
 - Experience of Shanghai teacher to their school: what they learnt about culture/context, pedagogy, didactics;
 - what has been adopted / adapted as a result of exchange, future plans, support needs;
 - the mastery agenda.

- *Interview schedule for head teachers*
 - Reasons for engagement in project;
 - choice of classes and teachers;
 - choice of specific text book series;
 - policy implications, cost implications.
- *Lesson observation schedule*
 - Pedagogy: what is different? What is the same?
 - Didactics: what is different? What is the same?
 - How mastery is interpreted?
 - Possibly invite parents in to observe and debrief.
- *Impact*
 - Measurement of pupil progress or learning;
 - whole school dissemination strategy;
 - parental engagement.

2.3 Strand 3 – Mathematics Hub Impact

The influence of the East Midlands Mathematics Hubs is examined here in relation to how they have supported translation of teaching originally located in Singapore and Shanghai into an English context via the national projects. To do so, we have looked at *reach* - the geographical spread of schools with working relationships with the mathematics hubs – and *depth* – the extent of support teachers have accessed from the Mathematics Hubs. Data relating to the extent, if any, that the Mathematics Hubs have mediated new ways of thinking about mathematics teaching will also be generated from interviewing and observing stakeholders.

The findings of the research are based upon:

- Interviews with 25 current primary school practitioners who have been involved with the national projects in a variety of capacities.
- Observations of pupils being taught using Maths - No Problem and Inspire Maths textbooks.
- Consultations with educationalists involved in the national projects.

Data collection took place between January and June 2016.

3. Textbooks and Professional Development Project

Singapore Textbooks - Key Findings:

Participants said that the CPD they received as part of the trail helped them to use the textbooks with pupils.

Appropriate training opportunities are vital; practitioners require an understanding of the philosophy that underpins a Mastery approach if the textbooks are to be utilised successfully.

It is very useful to see the classroom practice – teachers can gain valuable insights from fellow professionals who have experience of using the textbooks

Teachers like the structure and planning that the textbooks offer – having well thought out questions and examples is particularly useful.

The textbooks provided teachers with helpful examples and resources to address specific learning objectives. For example, comparison (difference) between two digit numbers involving subtraction.

As the Mastery approach requires time and a shift in ethos towards studying concepts for longer and in greater depth, teachers need support from senior leadership and mathematics coordinators to instigate this.

Contributors have said that their pupils enjoyed using the textbooks and the style of teaching.

Participants said that they felt the textbooks had a positive impact on pupils, especially on the higher and middle ability range pupils.

Contributors have suggested the real value of the textbook project was that pupils engaged with this approach, though there is little hard evidence of greater achievement.

There are some classroom management issues that have to be overcome. For instance, it can be difficult to get all children in a class to focus on the same page of a textbook.

Many practitioners felt that the pupils do not need an individual textbook. Rather, it is more appropriate to present topics to the whole class using an interactive whiteboard.

The textbooks are year specific, some class have mixed year groups, e.g. reception and year one. Teachers have to resolve this issue in a way that suits their particular circumstances.

Some participants suggest there is the need for appropriate additional assistance and support for pupils who are not keeping up.

There are significant financial questions about affordability relating to use of the textbooks.

3.1 Project Implementation and Organisation

Feedback from participants indicates that they believed the first year of the Maths textbook trial was introduced and implemented successfully. Head teachers of participating schools reported that they had a clear understanding of: (a) the purpose of the project, (b) what the trial was intended to achieve and (c) their schools' role within the research. In addition, the teachers who took part in the project said that they have fully engaged with the textbook trial and associated CPD opportunities.

Many of the Head teachers who helped with this evaluation said that prior to taking part in the textbook project, they felt the mathematics provision in their schools was good. Suggesting that they had chosen to become involved because they are continually looking for areas for improvement. Typical responses included:

If schools don't engage, if schools don't keep learning, practice can't develop.

(Head teacher)

We were really interested in whatever will make maths teaching better. And whatever will support children for the future to make it even better, for better outcomes.

(Head teacher)

This orientation toward good mathematics provision may have influenced the outcomes of the evaluation but we are not able to conclude that the findings would be observable from a wider range of school provision.

3.1.1 Continuing Professional Development (CPD) requirements

Participants' overall assessments of the CPD opportunities which they received as part of the trial were very positive. A representative cross-section of responses is shown in **Table 3.1**. The practitioners who were consulted indicated they had enjoyed, and benefitted professionally from, the training. Significantly, they said that it supported them to utilise effectively the approach set out in the textbooks. For instance, a Year one teacher said:

I am fortunate to have had the training, so when you are following the programme it makes it a lot easier. It sets out the delivery of the lesson and the materials, it's very clear on what you need to do for guided practice, what you need to do for your mastery approach, what you need to do for your in-focus task.

(Year one teacher)

Respondents reported that the CPD courses had emphasised the importance of:

- Process not answer
- More time to explore initially
- The use of concrete objectives
- Letting the children have a go at solving problems

Table 3.1: Practitioner Evaluations of the Textbooks Project Professional Development

Overall Impression of Training Received:	
Brilliant	Teacher
It was a good opportunity	Teacher
It was fantastic	Maths lead
It was really useful	Teacher
Really useful	Maths lead
The pedagogy bit was very strong	Maths lead
Very high quality	Maths lead

3.1.2 The importance of prior training and preparation

Practitioners have stressed the importance of adequate CPD and being properly prepared so that the Singapore style textbooks can be used effectively within the classroom. The Head teacher of one school, for instance, remarked: *'it does need training, it does need support'*. This notion was reinforced by the principal of a different school who said: *'it's not about the textbooks, it's about the methodology, and if you don't understand the methodology you're not going to get the textbook'*. This point was expanded upon by another head teacher:

For me as long as there is a real understanding of what mastery teaching actually means, what it looks like. Because if practitioners don't know what it means, or how they should be teaching, then it would go horribly wrong. Therefore, there has got to be the underpinning knowledge, there has to be the continual professional learning for practitioners so they understand in order for them to do it well, otherwise mathematical attainment will drop.

(Head teacher)

The potential difficulties of using the textbooks without firstly undertaking the necessary background work was underlined by a maths lead at a participant school, who argued:

I think that there are implications around training the teachers. Because I think if you don't have the training that we have been on the potential is there for the teachers not to be on board and not to use the materials effectively, because they would just be guessing how it works, so that is huge the training.

(Maths lead)

The necessity for suitable planning and support before using the Singapore textbook with pupils was also emphasised by teaching staff. For example, one professional said that teachers who will be delivering it: *'do need training to put them on the right path'* (Year one teacher). A different participant stated that prior to starting the trail she realised:

I need to be able to do a lot more research, I need to get some resources together, I need to change the way my classroom is organised, change the way I'm going to allow the children to work, because it's completely new. So that needs thinking about, and I had to work it out in the classroom, right how am I going to introduce this, what are my lessons going to look like, have the children got access to resource?

(Year one class teacher)

3.1.3 The value of practical examples / illustrations

Practitioners have noted that it is particularly valuable for training or induction programmes to provide practical illustrations of the way the textbooks can be used within the classroom setting. A contributor said: *'as teachers we want to see what it looks like so we can put it in the context of our classroom'*. Correspondingly, the majority of participants suggested that they found the second set of training (when the trail was underway) more beneficial. As one practitioner noted: *'the second part of the programme actually identified yes we are doing it right, yes we are using the correct method, we are getting all the key elements in there, really useful training'* (Year one teacher). Participants said that at this stage they also had a better understanding of the type of advice and assistance they would like to receive. Speaking about a Year one teacher at her school, a maths lead observed, they: *'needed to do the teaching and put it into practice and come up with her own questions and things that she wasn't quite sure about'*. A teacher at a separate primary school reinforced this point saying:

Having seen it and had a go you had something to discuss when you got back, having fellow teacher there who were having similar problems to you, or solutions to things that you were finding tricky that was really valuable.

(Year one teacher)

Consequently, it is advisable that future textbook CDP should draw upon the insights of those who have previously participated in the trial. Their understanding of the way it has worked

within the classroom can supply practical examples that other professionals may find useful. In addition, their work highlights potential pitfalls and solutions to problems that other professionals might encounter. A maths lead said that: *'the how to use the textbook stuff, I think will be better now it has been used in schools and they will have stuff to talk about'*. Considering the opinions and experiences of fellow professionals can also help to pose questions, which teachers may want to consider before using the books with their pupils.

3.2 A Mastery Approach

The available evidence indicates that the textbook project has helped to add to expertise in teaching mathematics in participating schools. In particular, it has been highly effective in generating enthusiasm amongst professionals, motivating teachers to think about and enhance their understanding of mathematics education. As one Head teacher explained: *'I hadn't expected [this] enthusiasm from the staff that are doing it, and that is a massive bonus. They are really quite into it for want of a better expression'*. This viewpoint was supported by the comments of a maths lead, saying of mathematics teaching at their school: *'there does seem to be more positivity about it and people are interested'*. Another infant school maths specialist remarked that: *'there was an awful lot of interest in school'* and went on to say, *'teachers are really, really interested'*.

Teachers working at a variety of primary / infant schools have also reinforced this point, saying such things as:

It has kind of reignited my passion for maths, plus I can see how it is having really positive implications on my year one, and how they are so much more solid.

(Year one teacher)

I do feel it has completely changed my attitude to maths, it's made me do my research a bit more and it's enthused me.

(Year one teacher)

The practitioners who took part in this research were able to describe aspects which they felt were important components of a Mastery approach, however this often fell short of articulating a coherent set of principles and beliefs. Perhaps most significantly, participants repeated the idea that *"all children can master the curriculum"*, but were not able to demonstrate or articulate what would be needed in practice to bring this massive change

about. One way this idea has been manifested is keeping all pupils in a class working together on the same topic. A Year one teacher said: *'I suppose maths mastery for me is everybody together, that's the big change; differentiation has been changed, so it is kind of that everyone mastering it together'*. This was supported by a fellow Year one teacher, who reflected that:

I understand about the mastery teaching approach, no ability groupings within your class, all of the children learning at the same time and then having mastery through depth. So basically not moving on too quickly to higher more complex problems, really solid basic understanding of numbers and how they work.

(Year one teacher)

An additional element of Mastery which all participants emphasized, was the centrality of enabling every pupil in their class to acquire a deep understanding of the mathematics they are learning. The Head teacher of one primary school commented: *'for me mastery teaching is about that depth of knowledge'*.

Whilst the language of mastery was secure, the underling practices needed to bring it about were less so. There was a sense that it was "all in the books" – an understandable response.

Participants stated the view that the Mastery of facts, procedures and concepts requires time. The notion of studying concepts for longer and in greater depth, was described by practitioners as essential for secure learning but was a deviation from current practice. Embedding such an approach was regarded as essential if teachers are to use the textbooks as an effective means of teaching for Mastery.

Adopting the features of a Mastery Curriculum for Mathematics, such as: fewer things, greater depth and longer time on topics, can be problematic for teachers if this is combined with the pressure to achieve high grades quickly (Lamon, 2007). This indicates the need for senior leadership to support practitioners who are teaching for Mastery. A maths lead stressed for instance:

I think you have got to change your whole ethos as a school, your philosophy on teaching maths because years upon years' teachers have been trained to move children through material as fast as they possibly could to get to a certain point. Whereas now the thinking is you actually get the children to understand very deeply, and that is a shift on teacher knowledge, teacher expectations, a huge difference in the way the whole staff would feel about teaching maths.

(Maths lead)

This testifies to the radical (“huge”) change in practice required into put into operation the underpinnings of the Mastery approach. Indeed it masks the question of whether implementation is indeed possible given the current organisation and structure of schools and curriculum.

3.2.1 A Mastery curriculum

An obvious means of raising standards in maths education is by enhancing the programme that pupils are following. Those consulted felt that the textbooks were helpful in this regard. The views expressed by the majority of participants were effectively summarised by the comments of a teacher who said:

I really like the textbook, the teacher’s guide, the planning is very good, it’s very thorough it gives you lots of understanding about where the session should go it’s very prescriptive. So we use that as a base for all our planning.

(Year one class teacher)

This was reinforced by a maths lead who said that: ‘*you always know exactly what you are teaching and what the children have to do*’. Practitioners have suggested that the key benefit of using the textbooks is the structured approach which they provide. For instance, a primary school head of maths said:

The reason we have bought into the textbooks this year; I think we have got it from a philosophical point to view the thing that we are struggling with a little bit is the lesson design and the lesson structure is a massive thing to get your head around. Choosing the correct examples and questions and it takes an awful lot of expertise to be able to do that. Why would you spend all of your time doing it if it is there available?

(Primary school maths lead)

Having a well thought out approach to presenting all pupils with central mathematical concepts, and illustrating the connections between them, was seen as the principal value of using the textbooks. One practitioner said: ‘*The advantage of the schemes is they give that range of representations that are difficult to find, and not everybody has the level of maths knowledge that they can devise it themselves all the time*’. A teacher revealed that their school had been watching the trial with interest, and had decided to go down the textbook route. This was because of the planned way they present material to pupils:

I think the problem for us is we have so skilled our staff up in terms of the MaST pedagogy and they are able to deliver the Mastery, they work from a problem solving

approach. But what we are lacking is the structure and the resources to ensure that mastery is achieved. Because sometimes the jumps between the resources the children use, or the tasks that the children do, are too big they need smaller steps.

(Infant school teacher)

The downside of such a well-thought out approach set out in textbooks is the little flexibility and engagement in curriculum decisions left to teachers. If the planning and pedagogy is all in the book, it requires deep knowledge of the aims, purposes and strategies behind the design of the (textbook) curriculum. The imposition of the textbooks precluded this. The following example illustrates this danger.

3.3 Using of the Textbooks - A Focused Case Study

The following example is based upon a case study of a Year one class. Pupils were working to solve word problems finding the difference of two digit numbers; (Maths No Problem 1B).

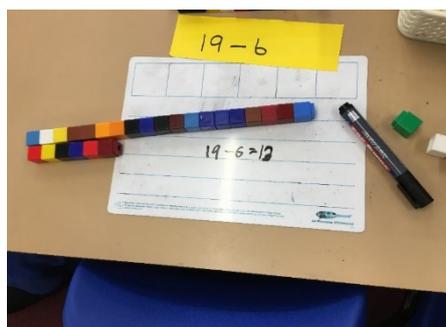
The activities in the hour long lesson were characterised by a range of representations and of the mathematical processes, with little explicit focus on the forms of representation.

- Clapping to count in 2s and 5s
- Moving on a 100 grid
- Using Unifix rods
- Drawing iconic representations

The teacher presents a problem graphically on the whiteboard with a line drawing:

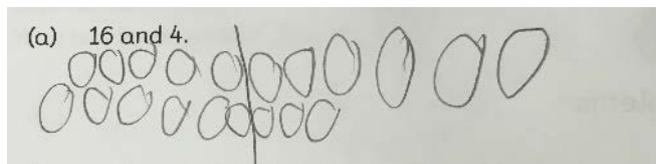
Two children, one has 7 sweets one had 11, what is the difference?

Pupils first count the objects in 3s and one girl does in 4s to find the difference. Pupils are then sent back to desks and asked to do this with Unifix cubes writing their solutions on mini-whiteboards. Pupils work in pairs at each table.

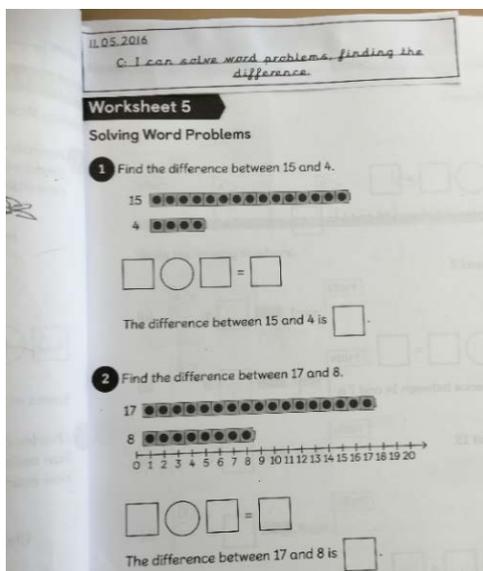


The justification here is to get children to come up with their own solution (Interview data) and this seems to be extracted from the assumed principles of Singapore and Chinese approaches.

Pupils were then given similar questions, to do and show on whiteboard by drawing small rectangles or circles:



The layout was important in getting the right answer but seemed not to be appreciated by the pupils and was not helped by the medium of the whiteboard. Some pairs of pupils were adding both numbers having drawn all the circles. The nature of the activity going on round the room made it difficult for the teacher to pick this up.



Pupils were then brought together and shown the first diagram below on whiteboard.

The purpose here would seem to be a transition from objects to number line – since it is the dots on the cubes which line up with the numbers on the line, though this did not seem to be exploited in the lesson.

What was taken for this representation was the use of objects *per se*.

The teacher introduced a method for subtraction by presenting a problem in language: I have 16 slices of pizza and the TA had 7, how many more did I have?

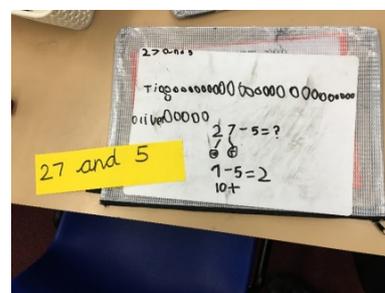
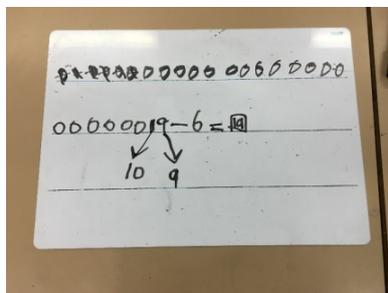
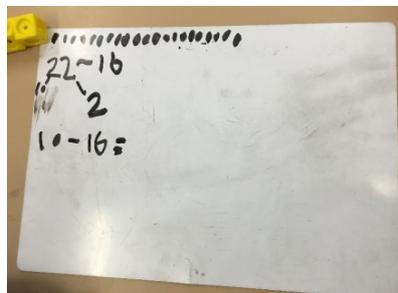
$$\begin{array}{r} 16 - 7 \\ \swarrow \searrow \\ 10 \quad 6 - 7 \end{array}$$

Now take 7 from 10

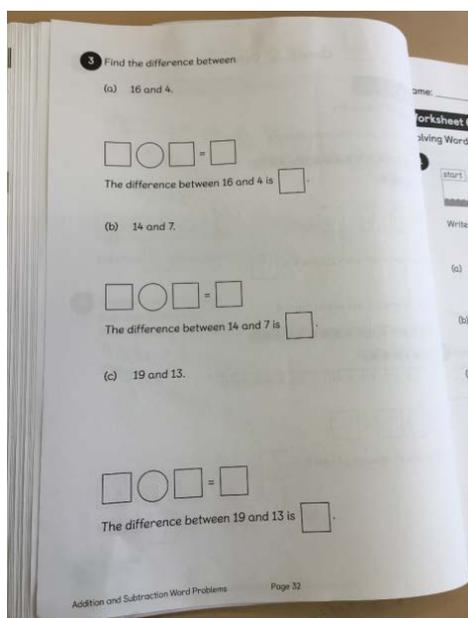
$$10 - 7 = 3$$

$$6 + 3 = 9$$

Pupils were then asked to go back to their chairs and do this with the cubes writing on the whiteboards. It was not clear that this method was internalised by many pupils.



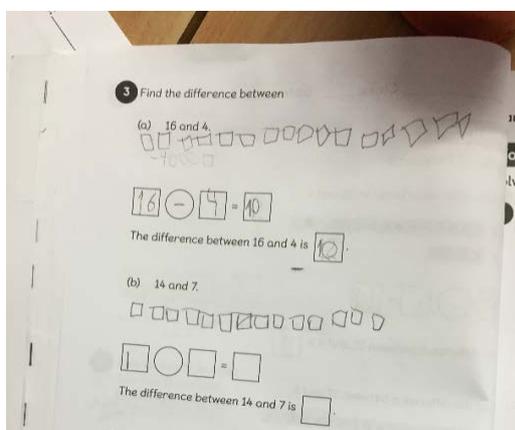
As a final activity, pupils were then asked to complete Page 32. This had three examples:



Find the difference between:

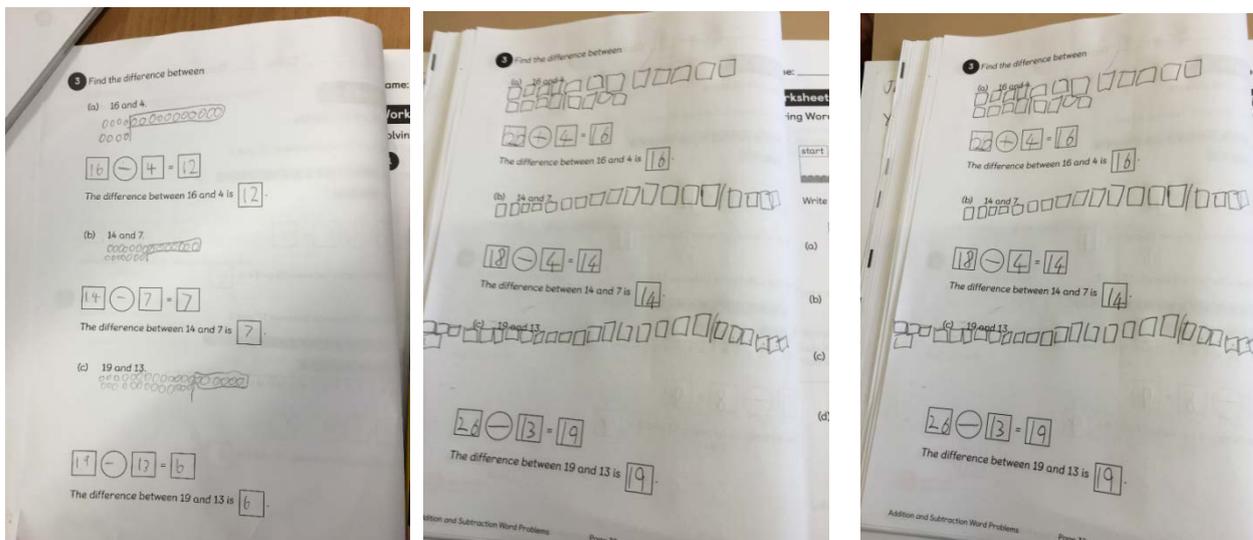
1. 16 and 4
2. 14 and 7
3. 19 and 13

These three are carefully designed to require three different approaches (unit-unit, decomposition; ten-ten) yet were approached using a singular iconic approach. This seems to be an example of evading the opportunities in the textbook through a lack of “total immersion” in the pedagogical culture.



Here is one attempt where it is not clear what the pupil’s thinking is – or indeed where one might see “mastery”.

Other examples...



Notwithstanding counting errors in the first example, this is fairly accurate but depends to a large extent on accuracy in layout and counting

In all pupil work there seems to be a lack of awareness of appropriate strategies behind the *specific* numbers.

3.4 Classroom Management

Many of the practitioners who have taken part in the trail mentioned that there are some challenges relating to classroom management when using the textbooks, especially with young children. A year one teacher remarked that: *'We don't have additional support in our classrooms, so trying to get 30 children to turn to the right page when they are five, to understand what they are doing is tricky enough'*. Going on to say: *'Because it takes such a lot time to get the book out, to get them sorted, to find the right page just make sure they are all doing the right thing'*.

Observations of classroom practice revealed similar complications when using the textbooks. For example, when looking at numbers 1 – 20 pupils have to turn to a much higher page number within the books. While it is understandable that such content has to extend beyond the first 20 pages, it seems somewhat paradoxical to say - *"Today we are looking at numbers 1-20. Turn to page 83"*.

Other participants also mentioned similar issues within their schools, for instance, a maths lead stated that:

That idea that a 5-year-old, just 5 years old some of them, have got this book, they have got a work book a textbook they have got all these manipulatives, they have got a whiteboard and pen on the table in front of them. And it is managing that, because small children fiddle and poke and don't turn to the right page and actually that hadn't been thought of, that classroom management. And every school has had to deal with it in different ways and find their own way around that management.

(Maths lead)

Different institutions had found their own solutions to this difficulty. The majority reported that they preferred to have the children's attention focused at the front of the class, making sure that they could monitor their connection with the activity. For instance, one teacher said she preferred to have the activity of the whiteboard screen: *'so I'm sure that everybody is looking at the right page, looking at the right area and I'm directing them to there'*.

As a result, some teachers said they would like to have access to additional interactive resources so that the class could work together. Participants' comments include:

If they were an interactive white board resource it would be easier to teach. Children are used these days to looking at the interactive whiteboard most of their lessons. So they don't necessarily need the textbooks.

(Maths lead)

I scan the page into a smart notebook and present it that way, which means that I can adapt it, I can cut bits I can draw on it and we can annotate it together.

(Teacher)

We had to buy visualizers because there are no interactive whiteboard resources, and there is a place for interactive whiteboard resources.

(Maths lead)

While the majority of practitioners reported that they found the workbooks to be a useful resource, many questioned the need for pupils to always have access to an individual textbook. For instance, a Year one teacher said: *'We use the workbooks more than the textbooks generally, for more convenience and for a better delivery to the children'*.

A maths lead at a different school came to a similar conclusion, remarking:

Actually the children don't need a textbook. What's in the textbook, the quality of the textbook is fabulous, but they don't need an individual textbook. If you have on your

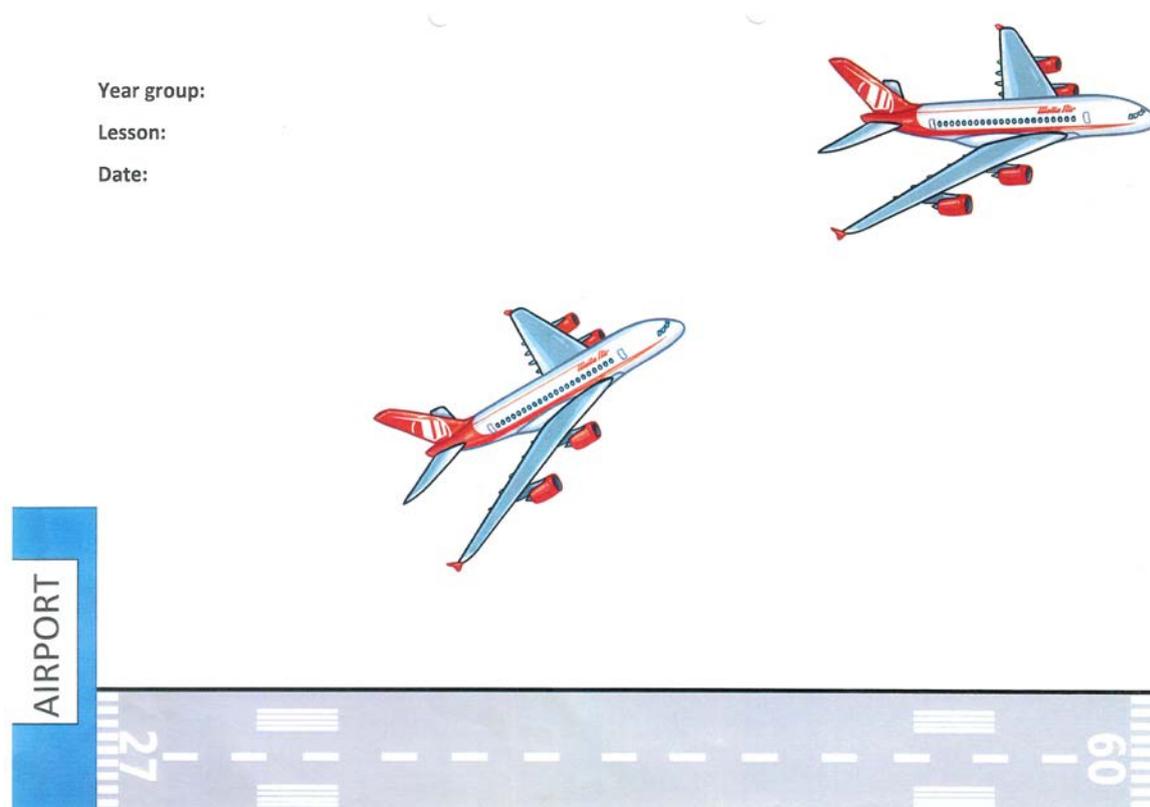
visualizer this is page 38 everyone look at this example, you can cover a part of it up, you know an interactive whiteboard resource that you can cover, and then the next slide comes is what you need really.

(Maths lead)

3.4.1 Ongoing assessment

Those who participated in the research stressed the need for ongoing assessment as an integral part of teaching, in order to continually check pupils' understanding of what they were learning. By doing so they felt they were able to monitor that the children were making the desired progress. Observations indicate that a range of formal and informal assessment procedures were being used by teachers during the learning process. For instance, a Year one teachers revealed she has been using an assessment system that involves monitoring individual pupils' understanding of each topic being taught (See **Figure 3.1** below).

Figure 3.1: Example assessment system



The visual representation shown in **Figure 3.1** was filled out during each lesson by the teacher and teaching assistants. This could then be used to monitor developments over time and

thereby try to ensure that all children were on track and making progress. The teacher concerned disclosed that doing this allowed them to plot: *'children that are on the runway, children that are taking off and children that are at high altitude'*. Going on to say:

So you would see from Monday to Friday what they're learning is, and if the children are still not moving there is a worry as we need to do something else. We need to get them to mastery we need to deepen their thinking deepen their understanding and get boosting.

(Year one teacher)

By constantly assessing pupils' progress the teacher said they were able to intervene swiftly to address misconceptions. It also presented the opportunity to adapt teaching and learning activities to reinforce student attainment. A Year one teacher observed that: *'In all honesty teaching it this way you see where the gaps are, and you can sort of think oh my goodness me they are not secure with that'*.

Interview and case study data suggest that checking on pupils' progress typically involves teachers seeking qualitative feedback. Teaching professionals were focusing on the details of understanding and performance in relation to the topic under consideration, rather than prescribed marking. Practitioners said, for instance:

We do a lot of marking at the time, at the point of teach and so you would be working with your group and you would talk to them and mark at that point of teach.

(Maths lead)

The children aren't actually learning anything from us marking these books. So she started to do a lot of peer marking, and talking about it in the class at that moment of teach, otherwise there is no value to the marking really is there, because the children aren't learning anything from it. And I think it's that because all the class are all learning at the same point, you keep checking everybody is at the same point and doing the same thing, obviously at different depths.

(Maths lead)

3.5 Impact on Pupils

The majority of participating schools we consulted reported there had been no formal external or internal evaluation of their pupil's learning as part of the textbook trial. However, there are indicators suggesting a positive impact at participating institutions. The most prominent being greater *engagement* of pupils. All of the practitioners who contributed to

the evaluation said that they believed their pupils liked using and were engaging with the textbooks. Typical comments included:

I think in terms of their enjoyment and their love of maths that's improved.

(Teacher)

I think the children are enthusiastic about maths, and I think they are enjoying it – definitely.

(Maths lead)

[Pupils] *like the style of teaching.*

(Teacher)

Another practitioner asserted that a sure indication of children's engagement with the textbooks is their willingness to speak about maths, saying:

They really want to tell me what learning they have done ... across all ability ranges the children are really enthusiastic about telling me what's happening.

(Maths lead)

One primary maths lead revealed that they initially had some reservations about using the textbooks. However, these concerns were eased when they saw the way in which pupils had connected with the books, asserting that:

The pupils really like it, we were – textbooks I'm not sure about this, we were all quite cynical, but they love it.

(Infant school maths lead)

A similar observation was made by a teacher from a different infant school, who said:

The children like it, they were excited at first because it is glossy and it is new and it is different, but again we were worried ... in September they were straight out of foundation you know they were straight out of it, and it is quite formal recording for a five-year-old. But they love it now, they love the pictures; they love the images.

(Teacher)

Pupil focus group - What do you think of the textbooks?

- *'They have really improved maths, because before we used the books I used to not like maths but now they are like more interesting and more fun as well as it helps you.'*
- *'I like them a lot because they show you new methods on how to do things, quicker methods, or longer methods that you can do.'*
- *'When I started on the book it was kind of hard because it's from Singapore I didn't understand the method and now I understand the methods it is easier.'*
- *'Before we started with the books I was kind of finding it harder to do maths, but when we first started using it on fractions, because I was struggling with fractions, so when we started using it, it has shown me easy ways and I started to get used to it more. So it really helps me understand because of the ways it shows.'*

3.5.1 Pupil attainment

Some contributors have suggested that overall using the textbooks has had a positive impact upon pupil progression. For instance, a participating school had used the National Foundation for Educational Research (NFER) test to help evaluate impact on pupils' attainment. The head teacher revealed that: *'the pupils who had done the Singaporean maths answered them better'*, also saying: *'it was interesting that there were more children who had got hold of the higher level questions'*. This was supported by the comments of another head teacher who was involved in the project, noting: *'I would absolutely recommend it, because it is very interesting and it seems to have had a positive impact on our children's results'*.

However, when asked about the practical implications involved in teaching for Mastery, specifically keeping the whole class working together on the same topic, teachers mentioned potential effects for both the more solid and weaker mathematicians. The majority of evidence which is currently available from practitioners, suggests using the Singapore style textbooks are not having a significant impact upon the lowest performing mathematicians.

The head teacher of a participating school had commenced an initial impact analysis and revealed that:

There is a difference in the results with the children who've done the Singapore maths texts and the children who haven't. ... actually it's the lower level students seem to have progressed the same according to whichever scheme they have done, but there is a push you have got less 'low middles' and more 'higher middles' and 'higher'. The curve has just sort of shifted a little bit.

(Head teacher)

This head teacher went on to comment that: *'it would appear that the better mathematicians are doing even better'*. Similar results have been reported at other schools, with a practitioner saying:

We had to do an assessment before they started and an assessment at the end. And the data showed that the more able children made a small amount of progress, the middle ability children made the most progress and some of the lower ability, you know, just sort of coasted.

(Teacher)

Some trial participants have expressed concern about being able to keep all pupils making adequate progress when using the textbooks. A Year one teacher revealed that she had some concerns about the weaker mathematicians within her class, saying: *'I think this next bit is becoming quite challenging and I think I am losing a few on the way, if I am honest'*. A teacher at another infant school asserted that:

I'm conscious that some children are being left behind, and I haven't got the resources to support those children to lift them up. There are some children who are clearly getting it, and some surprising ones from the lower ranks that are getting it. However, there are a group of children who aren't, so that is more of a challenge.

(Year one teacher)

Some contributors said they felt that helping some pupils achieve Mastery with greater depth was a potentially a problem. For instance, when speaking about the main challenge at her schools, a Head teacher revealed: *'I think for us it is about making sure those high order thinking children, they have the appropriate challenge'*. Similar concerns were expressed by a professional teaching at a different school, who said: *'I should be challenging my more able, but when you haven't got that support its tricky to do'*. This was also an issue that a teacher had faced at another primary school. However, they suggested that it was a potential obstacle that can be overcome:

The hard thing with that mastery is everyone moving together, there are those children ...that do rapidly grasp things, the rapid graspers as we call them, so that is where my challenge is for me. But I think I am getting better in my practice, because rather than giving them bigger numbers or more to do it is kind of thinking of how can I extend their learning in a different way, in a more challenging way. And that is the depth and breadth as opposed to the sort of vertical extension.

(Teacher)

3.6 Sustainability

It is not certain that all participating schools will continue using the textbooks. The main barrier to continued use seems to be financial. For instance, participants have commented:

We just haven't got that money, and I don't think any schools have in the current economic climate.

(Head teacher)

I know we don't have money to buy books across the school.

(Maths lead)

As a school we have more or less decided that it is not worth it financially.

(Head teacher)

If I was going to do it, yes I am going to do it full blown the whole thing; the cost could be £1,000 a class per year. That's not going to happen; schools can't afford that, that is just not going to happen.

(Head teacher)

Following on from the trial a number of schools have said they will continue using the textbooks. Others have said they will definitely be expanding their use with other year groups. Two participant school have confirmed that they will be using the textbooks with all year groups from the start of the following academic year. Comments include:

I will definitely continue using the teacher's guide and the planning.

(Teacher)

We will go Year one, Year two next year.

(Principal)

Actually I would like to go whole school, but it is going to cost.

(Head teacher)

Some schools who were not involved in the trial have also stated they have been using the textbooks, and will continue doing so. For example:

It's not a cheap thing, but we have invested heavily in it and we are going for a big investment next year.

(Maths lead)

Therefore, in terms of long term sustainability the indications are that whilst capital expenditure was possible, recurrent expenditure at the level of the books is perhaps unsustainable. While ongoing funding is questionable schools might get enough input to eventually go it alone with the textbooks, without paying for workbooks and on-line support.

3.7 Summary of Conclusions and Recommendations

The interview evidence provided by contributors indicates that teachers claim the Shanghai style textbooks provide schools with the opportunity of having well thought out resources, and presenting a scheme in a consistent way across year groups. The teaching methodology facilitated by the textbook means that regardless of notions about ability level, whole classes are being presented with a set of central mathematical concepts and ideas at the same time – this is indeed part of the Mastery narrative. Consequently, they seem to offer the possibility of a Mastery curriculum, which affords all children the chance of acquiring an understanding of the key ideas and building blocks within mathematics. However, a curriculum cannot alone provide a Mastery approach, because it is being injected into a pre-existing culture of teaching and learning with a pedagogical architecture that mirrors decades of a different approach. All effective approaches to Mastery in mathematics will require guidance on changes to teaching in addition to an appropriate structure, making appropriate CPD vital. Most significantly it requires a 180° turn in teachers' thinking on pupils and learning – away from entrenched ideas of fixed **ability** toward a more flexible view of capability.

Observation evidence indicates that there was no evidence of a structured approach to conceptual representations in the lesson or even in the textbook, though this might have been apparent in the on-line teacher's guide. There was evidence in the books of a possible structure in the variety of exercises; though these were not made explicit in the lesson.

The practical activities which were observed drew on a set of physical or visual representations without a clear and explicit identification of the link between problem and strategy. This likely to be the result of the import of a different pedagogical strategy with insufficient training, resources and time. Practitioners have emphasized that using the

textbooks is not a quick fix. Schools need to be fully prepared and introduce them as part of an integrated approach to teaching mathematics. As one maths lead commented: *'It does need a warning that it isn't the answer to solving maths problems in your school, there is a lot of work and understanding that goes into it'*. The ideal scenario seems to be having teachers who understand Mastery teaching, who then use the textbooks as a way of providing a structure, well thought out examples and questions.

Participants have stressed the value of undertaking CPD prior to using the textbooks within the classroom. Advising that this enables teachers to consider whether they are obtaining the maximum benefit from the textbooks, or whether they are using the structure and organisation which they offer in a superficial way. A contributor said: *'That was a worry that some staff were going to pick it up, put it in place without thinking about it. Without saying is this working, is this not working, what could I do to change and adapt?'*

This points towards a potential weakness that practitioners may use the textbooks alone, without adequate CDP or an appropriate understanding of the reasoning behind what they are doing. Thus, contributors made it clear, there is a requirement to have a sound grasp of the fundamentals that underpin teaching for Mastery. Therefore, it is highly recommended that in the future professionals who are or will be using the textbooks have access to support and development opportunities so that all pupils are able to make good progress.

The overall impression appears to be that the textbooks can help, but seem to be being injected into a procedural culture already established and embedded in classrooms rather than incorporating the culture that would be normal and unquestioned in Singapore.

4. England – China Teacher Exchange

Shanghai Exchange - Key Findings:

Feedback from participants has been very positive regarding the way the England – China teacher exchange was carried out, both during and after exchange phase of the visit.

The practitioners who were involved in the project have said that it has been an effective means of transmitting information about the Shanghai approach to mathematics teaching.

Participating schools have engaged with the exchange – all the teaching staff have been encouraged to observe at least one taught session with the visiting professionals.

Teachers from across the region said that participating schools have been welcoming, accommodating them to observe the Shanghai teachers delivering sessions.

Schools have reported they are adapting their practice based upon what they have discovered. For example, switching to a shorter maths session in a morning and a follow up session in the afternoon.

Teaching professionals suggest they have adopted parts of the Chinese approach – ‘cherry picking’ the best bits for their classrooms.

The main features of the Shanghai style of mathematics teaching, which many practitioners said they had picked up on were:

- Greater depth
- Longer time devoted to topics
- The whole class working together

Contributors suggest ongoing continuing professional development opportunities are vital - developing teacher’s mathematical confidence has to be a priority to enable teaching for Mastery.

Collaboration between professionals is indispensable - teaching staff need to have time to work together and to share ideas.

The project is having an ongoing impact with practitioners being able to observe teachers within the region teaching in a style influenced by the exchange project.

Professionals have been able to engage with the project in a variety of ways. While the level of involvement has varied, it has helped to foster and promote exploration and development work that is still resonating within a number of schools.

4.1 Project Implementation and Organisation

Feedback from participants has been very positive regarding the way the England – China teacher exchange was carried out, both during and after exchange phase of the visit. The professionals who participated in the exchange said they had a clear appreciation that the project was a platform for experimentation and development work within their schools. As one principal explained, *'I just thought yes there might be a better way to do it and actually let's hear it and we can give it a go and be brave'*, expanding upon this by saying *'it was a wonderful opportunity that could broaden the outlook of staff members'*.

The overall structure of the exchange project was viewed as highly effective, in terms of the way participants were able to enhance their understanding of Mastery by going to Shanghai. Also, in the way the project has helped to expose a variety of practitioners from across the regions to the Shanghai approach to mathematics teaching.

The practitioners who went on the exchange visit had the opportunity to view the cultural and philosophical approach to teaching mathematics in China. The exchange began with two university days; at which they were provided with the background to the Shanghai methodology. The majority of dedicated time thereafter was spent in schools observing lessons and talking with teachers. A maths specialist who participated in the exchange made it clear that they found going to Shanghai a valuable experience, saying:

Visiting there, I think I needed to see it in context to really understand and select the best bits. We are very clear on the project we are not trying to replicate China, we are trying to take the best bits for us and I think I wanted to see what the best bits are and what were transferable and what weren't for myself and I think that was the best way to do it, going to China.

(Maths specialist)

This professional was clear that they were then able to share what they had discovered with the leadership and teachers from their own institution and other schools. A similar view was expressed by another maths specialist who said: *'I think engaging schools through going to Shanghai, seeing it first hand and bringing those ideas back, worked exceptionally well'*.

During the return phase of the exchange, two teachers from Shanghai worked at a primary school in each of the Maths Hub regions for four weeks. On average, they taught a lesson

each day, enabling a range of practitioners to witness at first-hand what a Shanghai style session looked like in an English context. Feedback from observers indicates that this has proven to be a highly effective means of providing UK based practitioners with an insight into this teaching method. Participating schools have said that they encouraged all teaching staff at their institutions to observe at least one session, they also welcomed colleagues from other schools across the region to see the Shanghai approach.

There is considerable evidence to suggest widespread interest in the exchange from a number of UK based professionals. The maths lead at a participating school said: *'We have got engagement; we have got positive feedback people saying we want more of what you are doing'*. Interviews and consultations with a range of professionals from across the Maths Hub regions indicate that many of them have taken advantage of the opportunity to observe the Shanghai approach to mathematics education. The majority said they have been able to incorporate some elements of what they observed within their own classrooms.

4.2 Impact and Effect

As the project has progressed, its sphere of influence has continued to expand from the schools initially involved to a host of other professionals. Currently it is possible to distinguish between four separate sub-groups who have been exposed to teaching for Mastery in a variety of ways. Primarily, there are those who were most directly affected: the teachers who visited Shanghai and practitioners whose schools were visited by teachers from Shanghai. However, there was also a great deal of communication beyond this, firstly to the range of practitioners who were able to witness the Shanghai teachers first hand. Secondly, to the practitioners who have seen UK based teachers who were involved in the exchange teaching in a style influenced by the project.

As **Figure 4.1** below indicates educationalists have been exposed to teaching for Mastery in a variety of ways as a result of the England – China project. Although only two primary school practitioners from each Maths Hub region went on the exchange, during the return visit many more had the opportunity to interact with and learn from Shanghai based practitioners. Based upon the estimates and figures provided by those involved, more than 200 professionals across the two regions have witnessed Shanghai teachers delivering a lesson. After this initial

phase of the project the work it began has continued with teacher being able to observe fellow professionals teaching in the Shanghai style.

Figure 4.1: Interaction with the Shanghai Teaching Approach



Those who took part in the exchange in the variety of ways, have all been able to give examples how this has had a positive impact on their teaching practice. Some of their comments are shown in **Sections 4.2.1 - 4.2.4** below -

4.2.1 Teachers who visited Shanghai

The practitioners who went to China who we interviewed were clear that this has had a real impact upon their teaching, saying such things as:

Everything I do I do differently now, the way I structure my curriculum the questions I ask, the way I structure my lessons – phenomenally different.

(Maths lead)

The children are still active learners, but it is much more of a “you do, I do, you do, I do” situation whereas before it would have been a 20-minute input from me and I would have lost, you know half a dozen children on the way.

(Infant school maths specialist)

A key change to practice has been: *'we move along together and get progressively more difficult', that's been a big change from constantly being told you have got to differentiate.*

(Maths specialist)

4.2.2 Practitioners whose schools were visited by teachers from Shanghai

The teachers whose schools were visited by Shanghai practitioners were all given the opportunity to watch them teaching. A maths specialist said, for instance: *'across the school when we had the Chinese visitors we ensured that everybody came to observe at least one lesson'*. The schools involved also encouraged teachers to use the trial as a developmental opportunity. A maths lead commented:

Seeing it in our schools over a period of time, having those four weeks, enabled our staff to pick up things for themselves. We made sure each member of staff saw at least one, usually two lessons and then had that structured discussions afterwards, pulling out key parts, what worked, what didn't work, things like that.

(Maths lead)

After participating in the reciprocal part of the exchange visit, the deputy head and maths lead at one school observed the impact on maths teaching for themselves, commenting: *'it was really interesting to see that each year group has seized upon one or two of those things that they'd seen in those lessons'*.

The exchange has encouraged participating schools to make changes to the way they deliver Mathematics, which they suggest are having a positive effect. For instance, a maths specialist said:

As a result of taking part, we now have a shorter maths session in a morning, about a 40-minute maths session, whereas before we had the traditional numeracy hour. But then that is followed up later in the day by the children doing some independent work, actually the duration is still the same, it is split over two sessions now.

(Infant school maths specialist)

However, it is too early to be in a position to have evidence that would allow us to evaluate whether this is having any effect on achievement.

4.2.3 Practitioners who witnessed the Shanghai teachers

The schools who hosted teachers from Shanghai were described as 'open' and 'inviting' by the professionals who went there to watch a session. Practitioner also said they have been

able to take part in a range of developmental opportunities due to the exchange project. A Head teacher revealed the she and the maths lead at her school:

We went to observe Shanghai teaching at a school in Nottinghamshire, we went to the lesson study meeting at the University. So we have tried to be involved with as much as we can, so that we are informed about it as well, because that is really important I think.

(Head teacher)

4.2.4 Practitioners who witnessed teaching influenced by the Shanghai approach

The principal of a host school said that the teachers at their school were ‘*very happy to share what they do*’, practitioners have been eager to take advantage of this opportunity. As participating maths specialist commented: ‘*It would be easy for me to fill up my classroom everyday with people who want to see it*’.

A practitioner who attended one of the sessions commented: ‘*I think they were very good at getting a lot of people in to see it. I think the sessions were very open, they were well publicised*’. However, there was a note of caution, one teacher pointed out:

They were well publicised to schools who are already involved. A lot of schools don't attend the Hub activities and therefore they don't get to see them. There are some areas where no one in the school will have been to see it. It was well publicised to people already attending things, if you are a small school and you are not in the loop or it isn't a priority – they will have got missed, they will have missed that opportunity.

(Primary school teacher)

This suggests that for a variety of reasons, some schools may not or cannot take full advantage of the opportunities presented to them. While this could be due to external pressures, for instance, some respondents cited being unable to find cover as the reason why they didn't attend a session delivered by a teacher from Shanghai. Perhaps it would be beneficial to find additional means to publicise future exchange projects or have supplementary webinars and online events.

4.2.5 CPD opportunities

Professionals have engaged with the project in a variety of ways, while the level of involvement has varied, it has helped to foster and promote exploration and development work that is still resonating within a number of schools. Practitioners have reported that it

has made them consider the possibility of doing things differently, and therefore, make changes that will enhance their practice.

As well as transmitting information about the Shanghai approach, the trail has also helped to encouraged teachers to increase collaboration to enhance their delivery of mathematics teaching. For instance, in conjunction with the Maths Hubs, one of the maths specialist who visited China has facilitated professionals to come together to share effective practice, explaining that:

We have 12 people come from different schools and we try and set it up like a lesson study or a teacher research group from China, where we discuss the lesson first and the intention, they watch the lesson then we come back and discuss it together.

(Infant school maths specialist)

4.2.6 Classroom practice

The main features of the Shanghai style of mathematics teaching, which many practitioners said they had picked up on were:

- Greater depth
- Longer time devoted to topics
- The whole class working together

Contributors have said for example:

It is very logical the order that they approach things in and very slimmed down so they get the basics right first and make sure they are deeply embedded before we move on to anything else. Actually it just makes sense to me compared to the way that we have been sort of trying to overload the children when they have not really understood the basics.

(Maths specialist)

It is the idea that everyone moves through the curriculum at broadly the same pace, all of your time out of the classroom you spend planning lessons rather than assessing, it is much more I have done my assessment during the lessons, I know where my kids are this is the next step. Using instant interventions, not catch-up programmes, that idea of instant intervention. The way that the curriculum is structured, so rather than a couple of days on fractions autumn, spring, summer let's do it once and do it well, and spend three or four weeks really getting into it.

(Maths lead)

I think lots of people who have seen the lessons have adopted the small steps, the different representations, the different manipulatives, spending a lot more time on lessons. I think those have quite quickly been assimilated into a lot of schools.

(Teacher)

4.3 Summary of Conclusions and Recommendations

The England – China teacher exchange has had an impact on practitioners and teaching practice in a number of ways. It is possible to distinguish different levels of influence, between:

- a) Teachers who visited Shanghai;
- b) Practitioners whose schools were visited by teachers from Shanghai;
- c) Practitioners who witnessed the Shanghai teachers;
- d) Practitioners who have seen UK based teachers teaching in the Shanghai style.

It is possible to envisage another layer of communication taking place in addition to these - to include all those teachers who have witnessed the Shanghai approach themselves in one or more of these ways, and then taken this message back to their schools, sharing it with fellow practitioners. A danger in this layer of influence is that there is less certainly that the messages being relayed are valid interpretations.

All of those who participated in the review have said that no matter what their level of exposure to the project, it has encouraged them to undertake developmental work. There is also some evidence, from observations of teaching and interviews with practitioners, to suggest that some participants are changing their practice in line with what they have seen. The types of modifications participants said they are either implementing or considering are highlighted in the **Figure 4.2** below:

Figure 4.2: Influence of Chinese teaching

Whole class teaching	Pupils have the opportunity to take part in discussions and think about mathematics.
Carefully crafted lessons	Progression from simple questions at the start of the lesson to more complex by the end.
Use of correct mathematical language	Whole sentences describing mathematical relationships.
A logical approach	Linking topics to previous concepts.

It is interesting to consider whether these features can indeed be taken as a pragmatic definition of what “Mastery” actually means for practicing classroom teachers. As these have been observed in practice, it appears these are the manageability aspects of Mastery achieved through translation of a policy narrative through a filter of manageability.

The structure and approach used to organise the initial teacher exchange projects was an effective means of letting practitioners see a different approach to teaching mathematics. This has helped to spread the philosophical viewpoint behind teaching for Mastery and supported professionals to investigate good practice in mathematics and the differences these can make. As one contributor commented:

I think in terms of getting the philosophy across at the beginning of Mastery and the beginning of this change, being able to see it done in such a different way so consistently in your school and seeing it happening was a really powerful thing.

(Primary school maths lead)

However, as more professionals develop an understanding of a Mastery approach and it becomes embedded, so there may be the need to change the ambition behind future exchange visits. Rather than having a general aim of exposing practitioners to a different mathematical culture, they could instead focus on specific areas of practice. Thereby, placing an emphasis on teachers working together to understand what works in particular contexts and how this can be taken forward to enhance Mastery teaching.

There are suggestions that the project could have a lasting impact upon those who took part. The head of a participating school remarked: *‘I think the benefits of the project will be*

sustainable, I think we are embedding it in, I do think that'. There was also the suggestion that it will have a lasting legacy, by encouraging a culture of collaboration and sharing effective practice amongst teachers.

While, in one sense, those who witnessing UK based practitioners teaching in the Shanghai style can be thought of as most removed from Shanghai approach. This does not mean that they were least able to benefit from the project. In fact, there was a suggestion from some contributors that: *'I think you get more from seeing English teachers teach in a Mastery style'* (Maths lead). This element of the exchange has reached the widest audience, and can expand the influence of the project in a way that is sustainable and which can continue to develop.

5. Translating Singapore and Shanghai Teaching to an English Context

The Maths Hubs were set up in England 2014 to act as regional focal points for the development of excellent practice in mathematics teaching and learning⁶. Along with the NCETM the Hubs have promoted a Mastery approaches to mathematics by drawing on practices in east and south-east Asia. Amongst the highest profile ways in which this has been undertaken is via the national projects:

- Textbooks and Professional Development project
- England – China teacher exchange

The influence of the East Midlands Mathematics Hubs is examined here in relation to how they have supported translation of teaching originally located in Singapore and Shanghai into an English context via the national projects.

A Mastery approach has increased in significance to Mathematics teaching since it was made central to the update 2014 curriculum in England (DfE, 2013: 99). NCETM (2014) has suggested that for many schools and teachers, the shift to the new ‘Mastery’ curriculum is a significant one. Requiring new approaches to lesson design, teaching, use of resources and support for pupils. In spite of the benefits a Mastery approach can offer, implementation can present practitioners with challenges. Perhaps most significantly, NAMA (2015) have suggested that there is sometimes confusion over the meaning and use of the term ‘Mastery’, and what Mastery approaches to teaching and learning might involve – something we have been at pains to illustrate. Mastery has, for instance, also been employed as a synonym for ‘gifted and talented’ defining the highest level of attainment in the 2016 National Curriculum tests (DfE, 2014). This raises the question: *what do teachers within the East Midlands identify the term Mastery to mean?*

⁶ www.mathshubs.org.uk

5.1 Mathematics Mastery as a Recognised Concept

The practitioners who contributed to this evaluation felt able to articulate a set of principles and beliefs which they felt were important components of Mastery. In particular, a set of pedagogical principles were often mentioned:

- Deep rather than superficial understanding of concepts;
- pupils are taught together and access the same content;
- more time is spent on each topic.

Of course through interviews we are not able to ascertain whether these “pedagogical principles” were articulated in practice or indeed whether practitioners were able to translate principles into practices. Participants said, for example:

For me mastery teaching is about that depth of knowledge.

(Head teacher)

So to me mastery is that real deep understanding, and making connections to learning.

(Teacher)

It's about understanding the process of mathematics, and the tiny little steps in children's learning and very much drilling down into that.

(Deputy head)

I think maths master is when the children understand the concept of something very clearly and master it. So the maths Mastery to me is a way of breaking it down into smaller steps to ensure those links and that learning takes place.

(Teacher)

What is significant here is the language used by practitioners, and whether it can be seen as any more than a repeating of an official discourse. The metaphorical use of “depth” being very common but rarely is it operationalised. Significantly, all participants strongly advocated the idea that all children can master the curriculum. One way this notion has become visible in classrooms is keeping all pupils in a class working together on the same topic – a practice lifted wholesale from high performing Asian countries (Shanghai, Singapore, Japan, etc.). Practitioners have said:

Everybody is doing the thinking together, and everybody is doing the learning together.

(Teacher)

It is the idea that everyone moves through the curriculum at broadly the same pace.

(Maths specialist)

I suppose maths Mastery for me is everybody together, that's the big change; differentiation has been changed, so it is kind of that everyone mastering it together.
(Teacher)

No ability groupings within your class, all of the children learning at the same time and then having Mastery through depth.
(Teacher)

Whilst all these comments reflect one of the underlying principles of “Mastery” they do not illustrate a practical operationalisation. Neither, more importantly, do they seem to consider whether or not it is indeed possible for all children to access all content at the same time. Indeed one of the main reasons why Mastery learning was abandoned in the 1930’s was simply due to the impossibility of this aim. This is illustrated in the next section.

5.1.1 Potential confusion surrounding Mastery

Research participants had clearly engaged with the “official” language of the Mastery approach. They have all been involved with the priority projects in one form or another and involved with the work of the East Midlands Maths Hubs. As a result, it is perhaps not surprising that they have their own defined ideas about what Mastery entails. However, it is probable that those who have not been so closely involved are not approaching Mastery from such an informed position. Participants have suggested that they believe there are still pockets of the teaching community who are not well informed. For Example:

People are, they are wondering what Mastery looks like and there is some ambiguity out in the world about Mastery, and is it just for your higher attainers’ or you know, so I think we need to get the party line out there as well.

(Maths specialist)

There is a confusion about Mastery, which a lot of people don’t understand. The basic essence is in maths Mastery means we all master it. In the national curriculum sense, the government have now steered away from talking about Mastery because of the confusion. But still people like Fischer Family Trust ... they still see the top 10 percent of children who have got really, really embedded have mastered it. So Mastery is something obtained by the very select few, but actually Mastery in maths is about us all being able to master something. And I think that’s the problem.

(Head teacher)

5.2 Potential Challenges for Adopting a Mastery Approach

Some practitioners have suggested it is not possible to simply adopt a Mastery approach, as one head teacher noted: *'we cannot replicate what they do in Singapore'*. A teacher from another school in the region supported this assertion saying: *'you can't take a Singapore school model and just pick it up and expect it to work fully in an English classroom'*. Similar concerns were expressed by the Head teacher of a third primary school who observed: *'I also have huge concerns that when we have met teachers from Shanghai, when we have seen the models from Singapore, we cannot replicate what they have in their country here'*. A major difference between the two systems that most practitioners drew attention to, was the prevalence of Specialist Maths teachers in Shanghai:

We had the exchange teachers come over here and the difference is those teachers only teach maths, and then in the afternoon they have time to pick up the children in nurture groups and groups to go over things.

(Year one teacher)

There are so many differences and I think that is what we are fighting against really, because over there they will have a specialist maths teacher. They will teach that lesson to a large group of children and then they will teach that lesson again. They have the afternoon to plan, they have a maths meeting, all of those things we haven't got the resources for.

(Primary School teacher)

I think the professional development of the teachers is very interesting in China as well. They have a five year, where we have a one year NQT year, it is a five-year project where you have a very reduced timetable and the teachers are given a mentor who is a more experienced teacher.

(Maths lead)

Participants also mentioned cultural and philosophical differences between east and south-east Asia and England. For instance:

The way maths is taught in Shanghai compared to over here just in sort of physicality of the classroom – the way the classroom is set up. The relationship sometimes between the teacher and the pupil a lot different, you know the larger classes. We have actually had eight head teachers from China come over here last week [part of British Council Connecting Classrooms – Shakespeare project] and that was one of the key things they picked out really surprised by the setup of the classroom by the relationship between the teacher and the pupils.

(Primary School teacher)

The culture of teaching is very different in China; I think on a society level the respect that teachers have. The word for sir is laoshi, which means teacher in Chinese as well, so subliminally I guess all around people are very respectful of knowledge and information and passing on knowledge, which is something that is very different to the culture in the UK at the moment. The high esteem that they hold education and learning and knowledge, both the children realise and their parents realise, the grandparents realise that actually this is an investment in the future, both educationally and financially.

(Maths lead)

However, while practitioners have acknowledged that although Mastery is not an easy remedy or solution, many have suggested it is a journey they want to embark upon because they feel it addresses underlying problems. A Head teacher asserted that although it is not possible to reproduce the Shanghai or Singapore approach: *'I can try to eliminate the barriers to allow for it to work as well. We might get 80 percent there or 60 percent of the way there'*.

5.3 Translation of Mastery

The translation of Mastery can be conceptualised as the communication of a source set of practices, such as that located in Shanghai or Singapore, so that it can be employed in another location (in this case the East Midlands). However, translation could also apply to changing the form or nature of Mastery as it is moved from one location to another. Thus, it is important to consider whether Mastery has been transferred (transplanted) or transformed (altered) as it is implemented by practitioners. This raises the possibility that Mastery means slightly different things in different schools and to different teachers.

The methodology and philosophy behind the Shanghai and Singapore approaches to teaching mathematics are being effectively transmitted to a range of practitioners in the East Midlands through the priority projects. These teachers suggest they are then attempting to understand the commonality between the two, and how this can help them to develop and improve their own mathematics teaching. This indicates that UK based practitioners are taking ownership of Mastery by creating their own interpretations of teaching for Mastery, which they feel is appropriate for their pupils.

Some teachers have said they are adopting the Shanghai / Singapore approach to teaching Mathematics. Other practitioners have argued that the methodology has to be adapted to suit the needs of their pupils. For instance, the head teacher of a school which participated in

the textbook trial explained: *'I do think we have adapted certain things to make it work more for our children'*. This was reinforced by the principal of another infant school who commented:

I think you have got to take the best bits of anything that is ever given to you and do what's best with the knowledge you have. And any scheme that you are given is never perfect, it is always going to have gaps and it is always going to have bits that maybe don't suit that child for whatever reason you know.

(Infant school principal)

5.3.1 Selectively adopting Mastery strategies

Some participants have suggested they are being selective in adopting elements of a Mastery approach. For example, an infant school maths specialist said that they and the deputy head at their school went to observe mathematics lessons after they had participated in the teacher exchange, noticing:

It was really interesting to see that each year group has seized upon one or two of those things that they'd seen in those lessons. They thought yes, that is really transferable to what we do, what we can do in our class.

(Infant school maths specialist)

Other practitioners have made similar comments, such as:

I think we are just taking the best bits out of it. I think it would be silly for us to go right we are going to roll out this because they do it out there.

(Teacher)

I think we are taking the best bits that we can and hopefully seeing some increase from that. But if we want to make it even better, we have to adopt a few more things.

(Maths specialist)

Just in briefings drip feeding key bit that actually will make a difference to our whole school stuff, so the things that make a difference that if you can make a change.

(Head teacher)

Nevertheless, some practitioners have argued that Mastery cannot be reduced to a few tips or tricks, it is a philosophy that you have to embrace fully. For example:

We don't want to give licence to people to just chuck out any bits that they fancy. Because actually there are reasons for most of the things that are put in.

(Mathematics specialist)

I think you have to be brave and adopt it, it's not a thing that you can just tinker with, you can't paddle in it, you've got to fully immerse yourself.

(Head teacher)

The way in which a Mastery approach is implemented is therefore very significant. While there are structural and cultural differences between England and Singapore and Shanghai that mean it is not possible, or even desirable, to simply replicate every aspect of mathematics teaching from these regions. In order to secure significant improvements in the quality of mathematics teaching, it is essential that practitioners who wish to utilise a Mastery approach are willing to change their own style. To do this successfully will require educationalists to have a deep knowledge of the subject and pedagogy, rather than a superficial conception of Mastery. Consequently, the findings of this investigation support the conclusions of Boylan et al. (2016), who from their longitudinal evaluation of the mathematics teacher exchange, reported that:

The risk of an adaptive approach is that the scope of change is not well defined and may lead to continuation of existing practices under new descriptions or changes that are not well aligned with the intended Mastery approach.

(Boylan et al., 2016: 12)

6. Conclusion: The National Projects and Maths Hub Impact

The impact of the National Projects and Maths Hubs, Key Conclusions:

The East Midlands Maths Hubs are helping to foster a desire amongst professionals to discover more out about the development of practice in mathematics teaching and learning in general, and a mastery approach in particular.

The two national priority projects - Singapore Textbook and Shanghai Teacher Exchange have been an effective means of transmitting information about a Mastery approach. Both internally within the institutions taking part and externally to other schools within the region.

By enabling practitioners see some of the different approaches to teaching mathematics, the national projects create the possibility of doing things differently.

Via the national projects the Hubs are supporting change, by helping teachers to investigate good practice in mathematics and the differences these make.

The practitioners who took part in this evaluation revealed that they are not restricting themselves to a single source of information about Mastery. Rather the Maths Hubs are assisting them to receiving information from multiple sources.

The national projects are just one of the ways in which the Maths Hubs are influencing the development of practice in mathematics teaching and learning. Participants have also made reference to accessing other services and assistance they provide.

Through the National Projects and other activities, the Hubs are starting to help transform and change professionals practice, in particular they helping to reinvigorate enthusiasm for mathematics education within schools.

Teachers who took part in the research have said that both they and their pupils are enjoying and engaging with mathematics more than previously.

Many practitioners have said that they found the professional development opportunities provided by the Maths Hubs very useful.

The Maths Hubs are helping to create a community of teachers sharing experiences, expertise and effective practice between schools.

Practitioners said they valued the networking opportunities that Maths Hubs and priority projects provide, asserting they would like additional opportunities to discuss ideas with colleagues.

For a variety of reasons there are still some schools who have not taken the opportunity to fully engage with the Maths Hubs. It is recommended that additional means are found to try to involve them in the work of the Hubs.

There is a need for additional robust evaluation evidence in relation to the impact of the national projects, particularly examine the impact of Singapore style textbooks.

There is a need to address the ambiguity behind the meaning of “mastery” and to work with practitioners to understand it through carefully designed pedagogical approaches that fit the realities in UK Classrooms.

6.1 Effective Transmission of Mastery Information

The projects have been an effective means of transmitting information about the Mastery initiative, both internally within the institutions taking part and externally to other schools within the region. Some examples of the ways practitioners have described information flows resulting from the projects are highlighted below:

Examples of internal transmission
<ul style="list-style-type: none"> ➤ <i>We have tried to include other members of each team in each year group. – Head teacher</i> ➤ <i>I have delivered a staff meeting where I shared a Shanghai top ten tips. But also the expectations that every child should be achieving, and also to try and not move children quickly through material but actually do the in-depth. – Maths lead</i> ➤ <i>I have supported other staff, we have implemented it in year two, we are now using the teacher's guide in both of the other year one classes, so I am supporting staff with that. And I have done staff meetings and a governors meeting how it works and what affect it has on the children and how we are using it. – Teacher</i> ➤ <i>I've rolled out bits as maths lead in staff meetings. – Maths lead</i> ➤ <i>We did a demonstration in a staff meeting. – Maths lead</i> ➤ <i>The year two teacher has ordered a textbook, but again that is just to help here structure things, because she wants to know how they are presenting it. – Year one teacher</i>
Examples of external transmission
<ul style="list-style-type: none"> ➤ <i>We have had quite a few phone calls from schools wanting to see us teach ... so schools are very interested. – Maths lead</i> ➤ <i>We have had practitioners coming into school to talk to us and to observe teaching and learning as well. – Head teacher</i> ➤ <i>I have got an event coming up from the Maths Hub where I am inviting people from different schools to come in. – Maths lead</i> ➤ <i>Yes, schools have rung up, schools have observed teaching. – Head teacher</i> ➤ <i>It would be easy for me to fill my classroom everyday with people who want to see it. – Maths lead</i> ➤ <i>We have been ringing local schools and visiting local schools to see what their views are. – Infant school teacher</i>

The practitioners who took part in this evaluation revealed that they are not restricting themselves to a single source of information about Mastery. Rather the Maths Hubs are assisting them to receiving information from multiple sources. The Head teacher of a school taking part in the textbook trail said, for example: *'we had some training about Singapore Bar and different methods that we could use in school'*. While a Maths lead from another school mentioned: *'I have done quite a lot of maths mastery courses'*. There is evidence that the national projects are influencing practitioners at multiple points, assisting them to discover more about Mastery. For instance, a deputy head teacher at a school trailing the Singapore textbooks said: *'we went to see the Chinese teacher exchange, and we looked at their ping-pong thing and how they worked, and we tried that'*. A teacher working at a different school commented: *'We have done a lot of work on Mastery this year through the Hub ... we went to taking mystery out of Mastery, we have looked at the Singapore textbooks'*.

The national projects are just one of the ways in which the Maths Hubs are influencing the development of practice in mathematics teaching and learning. Participants have also made reference to accessing other services and support they provide, such as the extensive web-based advice on Mastery in mathematics available from NCETM and the Maths Hubs. Because of this it is difficult to isolate specific aspects of the work that the Hubs are undertaking, and say with certainty they alone are impacting upon teachers' pedagogical content knowledge and understanding and implementation of didactics.

However, it is possible to identify that via the national projects the Hubs are supporting the dissemination of an awareness of Mastery, by helping teachers to investigate good practice in mathematics and the differences this makes. The practitioners involved are not necessarily dogmatically following either of the projects, rather they are trying to understand which aspects are helpful, and evaluating how this can best develop practice. The emphasis has very much been on practitioners trying to understand what works within their classrooms. A head teacher who taken part in the textbook trail commented: *'for me it is more about the mastery, not necessarily the Singapore maths really. It is about the mastery and how can we improve teaching and learning through the mastery approach'*.

Contributors have indicated that taking part in the national projects and related activities have had a positive impact. The deputy head at a school participating in the textbook project noted:

I think it is very difficult to say just the Inspire, because we have been doing so much other work on manipulatives and other things. But maths just seems a little bit more vital, there just seems to be a bit more energy about maths in school and people are talking about maths a bit more.

(Deputy head teacher)

This infers that practitioners' understandings of Mastery are a hybrid of the different ways they are learning about the approach. However, a central set of principles and practices were reported by many as their central focus. These include:

- deep and sustainable learning;
- conceptual and procedural fluency;
- carefully crafted lessons;
- the majority of pupils' progress through the curriculum content together;
- the expectation that all pupils can achieve high standards in mathematics.

The comments of one maths lead encapsulate the general sentiment of many participants:

We didn't say right this is Mastery – this is what you need to do. Quite organically we were able to grow our own philosophy based around those key points. It wasn't a case of right this is what we have been told to do. Quite quickly in the space of a year ... I am not saying we are teaching for Mastery perfectly, we are not quite there yet - we have a long way still to go, but from a philosophical point of view getting those ideas embedded and getting that buy in from staff was absolutely fantastic.

(Maths lead)

Schools within the East Midlands report they have made changes to practice, which they suggest are having a positive impact upon pupils – though there is little in the way of hard evidence on which to base a judgement. In particular, teachers who took part in the national projects have commented that their pupils are enjoying and engaging with mathematics more than before and this in itself may be sufficient benefit. Practitioners have also said they too are enjoying teaching mathematics more, and that the energy and enthusiasm surrounding mathematics education in their schools has increased.

Those practitioners who were consulted agreed that the sharing of experience in the way promoted by the national projects is very valuable. They suggested that they would appreciate the opportunity to have more official meetings supported by the Maths Hubs to share ideas and findings. For instance, a teacher who took part in the textbook trail suggested that:

Other schools who are in the area, or schools that are just outside the area are invited to come together just to iron out questions, such as what chapter are you on, should I be there or which direction should I be going in and how are you delivering it and this is how I am delivering it.

(Year one teacher)

This was echoed by another professional who said:

It would be nice to meet up with other similar schools and share things that are going well, things that are not going so well. It would be nice to share what we have found with other schools. It would be good to sit down with colleagues and discuss way of improving practice.

(Teacher)

6.2 Implementing Mastery Requires Time and Expertise

Participants have said that mastery is not a 'quick fix', but it requires time. Not only for pupils to develop a deep rather than superficial conceptual understanding, but also for the schools and teachers delivering a Mastery curriculum to ensure consistency of provision in all classes. As a maths lead pointed out: *'we need time to do it properly and embed it and make sure everyone has a shared understanding about it'*. This was supported by the comments of a maths specialist from another school who said of Mastery: *'it is something that works, it has been shown to work in Singapore, it has been shown to work in Shanghai and it does work, it just takes a little bit of time'*. The approaches have, after all, been used for decades in Shanghai and Singapore.

The importance of teachers having a clear understanding of the pedagogical practices that underpin Mastery was emphasised by a maths lead who stated: *'If you are not secure with it yourself you are not going to teach it, and you are definitely not going to teach it well'*. The Head teacher at a different school was equally clear that teachers need a grounding in the essential ideas behind Mastery to use the approach effectively, contending: *'I think if there*

isn't an understanding of what Mastery teaching looks like the it could unravel horribly wrong'.

One way of embedding a Mastery curriculum, which has worked well for some schools, is to have a Mastery policy document. This details what the school is working towards, and the sort of practice they want to see in their classrooms. This approach has been implemented by one of the institutions that participated in the teacher exchange project. The maths lead reported:

At our trust we came up with nine mastery statements, we put it up on the notice board and put some stickers next to it, and people put a red sticker if they thought we are a long way from that, amber if we are about there, and green we are doing it. So right what is amber, we can work on this together, we will start to work on some of the red stuff, and kind of that idea this is what we are working towards but obviously we are not going to do it all at once. Take those small steps to where we want to be with it.

(Maths lead)

Although the national projects have helped to disseminate information about effective practice, some professionals have commented that it is not always straightforward implementing the changes they would like to in school. This seems to be especially true when teacher older cohorts who have not previously had experience of a Mastery approach. Speaking about the experience at their school, a maths specialist stated:

In year five and six they are adopting some principles of mastery, some features again cherry picking a few, but actually as regards the whole class teaching it is very difficult because the gaps are already quite established in the children's learning and there is a range of children's abilities, a very wide range in some of the groups.

(Infant school maths specialist).

The implication is clear; it is important to start teaching for mastery at an early stage of pupils' school careers. If this does not happen, there is the risk that gaps in attainment will have already emerged. In addition, some children in a class may have a superficial, rather than a deep conceptual, understanding of particular topics and areas of mathematics. Hence, keeping a class working together on the same topic would be less feasible.

6.3 Recommendations for Future Research

A key finding of this evaluation is the need for additional research involving practitioners and pupils, especially in relation to use of the Singapore style textbooks. While there is quite a lot of “soft” evidence supporting their efficacy, such as the observations of teachers and feedback from pupils, there is little “hard” empirical data to back this up. This is significant because, if the textbooks are proven to be beneficial, then more schools have suggested they will start using them:

So I've got to know that it works, and at the moment I haven't got that evidence, so the Maths Hub need to convince me at this stage that this is going to work and that if I do go whole school I am going to see the results from it.

(Head teacher)

Ultimately it is like anything; if the results do well you might be happy to spend the money on it.

(Head teacher)

We don't know enough yet for me to say it is definitely worth spending thousands on.

(Head teacher)

There is some empirical analysis provided by the Education Endowment Foundation, who conducted evaluations of mathematics Mastery. They report that:

1. On average, Year 1 pupils in schools adopting Mathematics Mastery made a small amount more progress than pupils in schools that did not. However, the effect detected was not statistically significant, meaning that it is not possible to rule out chance as an explanation.
2. There is little evidence that the effect of Mathematics Mastery differs between children with different levels of prior achievement.

(Vignoles, Jerrim and Cowan, 2015: 4)

Consequently, there is a need for additional robust evaluation evidence examining the impact of a Mastery approach, particularly on different pupil groups. This is the only way to ascertain whether Mastery is merely a form of words or whether it can genuinely bring about an improvement in mathematical attainment. This is about walking the walk not just talking the talk.

7. References

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