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# Teaching for mastery

A report on the impact of  
the use of the NCETM  
Primary Mastery  
Professional Development  
materials in 5 schools

Rachel Helme

**School of Education**  
University of Bristol  
35 Berkeley Square  
Bristol BS8 1JA

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Mastery Professional Development materials in 5 schools

By Rachel Helme

University of Bristol

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Contact: [rachel.helme@bristol.ac.uk](mailto:rachel.helme@bristol.ac.uk)

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SCHOOL OF EDUCATION

## Introduction

This report is a summary of a small-scale research project to investigate the use and impact of the NCETM Primary Mastery Professional Development materials in schools already participating in the Maths Hubs Teaching for Mastery programme. These materials were published between 2017 and 2019 and are available on the NCETM website, arranged under three 'spines': Spine 1: [Number, Addition and Subtraction](#); Spine 2: [Multiplication and Division](#); and, Spine 3: [Fractions](#).

Teachers in five schools were interviewed between January-May 2020. Four of the teachers were Cohort 5 Mastery Specialists receiving NCETM training in 2019/20, one of whom was from a school that had also been in a Development Work Group in 2018/19. The fifth teacher came from a school that was in a Development Work Group in 2019/20. The aim of the research and this report was to find out how the Primary Mastery Professional Development materials are being used and the impact of their use. The research was a collaboration between the University of Bristol's *Mathematics Education Research Network* (<http://www.bristol.ac.uk/education/research/networks/mern/>) and the NCETM.

The report is divided into the following sections:

- Executive summary (p.2)
- Impact on the experiences of students (p.4)
- Impact on how the participants think about and teach maths (p.5)
- Impact on other colleagues (p.7)
- How are the PD materials being used in school? (p.9)
- What are the key challenges reported in using the PD materials and how can they be overcome? (p.10)
- How was evidence gathered for this report? (p.11)

In each section distils the themes apparent from the interviews with the five teachers in the five different schools and aims to reflect the balance of views expressed in the interviews.

The Professional Development materials were created by a team led by the NCETM with substantial input from teachers trained as Mastery Specialists. The intention of the materials is to provide teachers with a conceptually coherent route through the primary curriculum. Attention has been paid, in these materials, to offer students a consistent set of representations of mathematics that, it is hoped, will become tools for students' thinking. Inspiration for the materials came partly from Chinese and Japanese textbooks, the experience of some authors in visiting China and having Chinese teachers visit the UK, and also other relevant research into teaching and learning mathematics. It is hoped that this report will support other schools in their use of the materials, through learning from what others have done.

The project researcher is grateful for the time given by everyone involved in this work.

## Executive Summary

The take-away message from this small-scale research project is that use of the NCETM Primary Mastery PD materials, where implemented across a school already participating in the Teaching for Mastery Programme and as the primary lesson planning resource, appears to have significant positive impacts on teachers and on students. The impact on teachers was felt particularly on their subject knowledge, confidence, and the precision of their teaching. In these schools there was evidence that **students are behaving in ways that have not been seen before**, in terms of their enjoyment of mathematics, their confidence in the subject, the ways they are able to use representations as tools for their thinking, and in terms of their ability to use reasoning and mathematical language. It also appears that use of the materials can serve to 'level the playing field' in terms of students' access to the age expected curriculum. In short, the materials may have the potential to effect a step change in students' achievement in mathematics at Primary School in England.

There is evidence that where the use of materials is more ad hoc, to support another published scheme, the impacts described above were *not* observed. Furthermore, a consistent finding was that, for teachers who have not participated in NCETM training, on first encounter the PD materials can be overwhelming, in their scope and detail. Such reactions soon dissipated if teachers were supported in their use and once changes in student behaviour in the classroom were observed.

## Recommendations

1. Schools need to commit to the use of the PD Materials as the primary basis for planning across year groups.
2. Participation in a Teaching for Mastery Work Group, organised by a local Maths Hub, is a key source of support for the maths lead in school.
3. Senior managers in school need to support and understand the key principles of the PD materials.
4. Schools should plan to provide all teachers with support, throughout the first year, for using the PD materials, including staff time to collaborate on their use.
5. A focus on the impact of the materials on students can be a driver for engagement by other teachers.

## What has been the impact of using the PD materials on the experiences of students?

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The researcher asked for stories about the impact of teachers engaging with the PD materials on the experiences of students in maths lessons. Six areas of change were identified.

### 1. Students are articulating their reasoning

Participants reported that in classrooms where the teacher is engaging with the materials, the students are having the opportunity for maths talk, using stem sentences, and applying correct maths language to explain their thinking. Some students are using the structure to create their own stem sentences, for instance:

**“That was just one of those lessons where I skipped around the classroom because they all got it and they have all understood it and they are all using the stem sentences, they are all doing their reasoning”**

It was noted that this is also evident in younger students (year 1) and low attaining students, who are behaving in ways that have not been observed before in the school, in relation to mathematics. One teacher commented on how staff have been:

**“blown away by how [students] were able to discuss mathematics at the end of year 1 in a way [we] had not seen a year 1 class do before”**

### 2. Students are making links and transferring their learning to new situations

Students are making links between topics and transferring information to understand different concepts, for example using knowledge of division to understand fractions, again, with a sense of behaviours that have not been observed in the past:

**“I have taught the same things for the past five years and this is the only year I can actually say they have really understood fractions thanks to the division and multiplication that went before it”**

Students are retaining knowledge and transferring this to new situations, for example the concept of zero and the impact of multiplying by zero for different integer values:

**“We have weekly mental arithmetic tests and when we did  $0 \times 5$  ... straight away they all got it right and I thought flipping heck, because that doesn't normally happen, they normally put 5 and ... I thought actually yes! they have retained that information”**

### 3. Students use representations for conceptual understanding

Students' experience of representations has moved away from method and process towards use for conceptual understanding. Consistent use enables them to focus on the maths rather than trying to understand the representation with the same representations being extended and experienced in various ways in different topics.

**“When they got the [Dienes] out and explored a selection of numbers, it was ‘I definitely can't make a square or a rectangle, I can only do it in one line so it must be a prime number'. I wouldn't have thought of doing that without the materials to support that as a structure”**



One participant stated that students believed that representations were useful for all levels of students, not just students who 'can't do it':

**"They don't see the representations and resources as for the children who can't do it and I think that is quite powerful ... They see the representations as useful, 'This is a way to show my maths' ... you can say 'Show me how you know?' and they will draw something"**

#### **4. Students have the attitude that maths is something you talk about**

The participants reported that students believe that maths is something you talk about and are empowered to debate and disagree:

**"My class will happily put their hand up and say 'I disagree with so and so because if you add this to that then that happens' and I think this is partly due to the discussions created as part of the materials because in previous years a child does not want to wrong, if another child was to say they disagree with them they would hate that, whereas now there seems to be a bit more of a dialogue"**

They are confident in using stem sentences, and correct maths language to articulate their reasoning. They stated that feedback from colleagues reiterated this point of view:

**"I think there is more of a general attitude throughout the school, of the children, that maths is something you talk about rather than something you do quietly ... I think there is a much bigger ... yes that maths is something you talk about, discuss, debate you know what is right and wrong, I think that is really nice for the children, it builds their confidence."**

#### **5. Maths is enjoyable**

The attitude of students towards learning maths is improving. As a result of feeling successful, students are stating that they enjoy maths:

**"If you spoke to any child about what their favourite subject is, it is always maths in our school"**

One participant described a particular student who had previously been below expectations and had not enjoyed his maths learning. His mother has reported that he is now saying that he enjoys maths and his end of year outcome shows signs of improvement:

**"Mum said 'You know he has gone from not liking maths to really enjoying it, I don't know what you have been doing with him, but he is really enjoying it'"**

#### **6. There are shifts in attitude towards who is the 'best mathematician'**

Students identify characteristics such as resilience or being able to explain well to another student as the mark of a mathematician. They recognise the importance of being able to unpick their thinking and having the confidence to make their own decisions about the efficiency of a method:

**"I set a task to ask the children in their class 'Who is the best mathematician in your class?' and see what they said, and I just did it with mine out of interest ... and they said really interesting things like 'it's such and such person because they explained the answer really well' "**

## What has been the impact of the PD materials on how the participants think about and teach maths?

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Researchers asked participants how using the PD materials had impacted on them as a teaching professional. They described the use of the PD materials in conjunction with the NCETM training programmes, which appear to be an essential part of successful implementation. Five different areas of impact were identified.

### 1. The participants feel more confident as teaching professionals

The participants gave examples of how their confidence as a teaching professional has been positively impacted as a result of engaging with the PD materials. They stated that using the materials helped them 'engage their brain' and as a result most teachers are adapting or extending the ideas presented in the materials, for example creating their own resources that enable the students to consolidate their understanding of zero. Some participants described instances where they have been confident enough to challenge the status quo in their school setting, for example arguing the case for verbal reasoning rather than written evidence during a book scrutiny. For one participant using the materials has made them feel more confident as mathematician:

**"I really really struggle with my confidence with maths but doing this has really helped me enjoy it"**

### 2. Teaching practice is deliberate and precise

The participants described changes that have occurred in how they plan and deliver maths lessons. By using the resources and guidance found in the materials, they talked about *deliberate* and *efficient* planning, that is they could identify easily the particular small steps, stem sentences and resources that are key to the current topic, recognising these elements will lead to depth of conceptual understanding. They stated that they are using the materials to plan links to prior knowledge and between different topics as well as to anticipate gaps in students' understanding.

The participants talked about *precise* delivery, that is they break down the learning into small steps securing student understanding at each stage before moving on. They focus on the correct use of stem sentences and maths language, as well as encouraging verbal reasoning by students:

**"I have done assessment for learning at the start of a unit and so on, but I have never actually thought 'Do they know what the language means? Have they been able to play with the language? Are they able to speak using the correct mathematical vocabulary?' And that is something that obviously the PD materials help you to do and I really like how they give you the stem sentences"**

### 3. Maths as a subject is seen as interconnected

The participants stated that they see maths as an interconnected subject with both links to previous and future work, and between topics and other subjects, e.g. geography. Using the materials enabled them to recognise the importance of the route through a topic rather than just the separate aims and objectives of each year group:

**“I have noticed how they pull in other areas of the curriculum all the way through. For example, we were looking at negative numbers in year 6, the way that they bring in coordinates and things like that and I would never have thought to makes those links”**

#### **4. Representations in maths are about understanding not methods**

The participants recognised that representations and concrete resources should be used to develop conceptual understanding rather than as methods or processes. Some described the number line as a representation that they realise can be extended, for example to understand multiplication and division:

**“We have always used the base 10 resources alongside a pictorial representation but in previous years that felt more like the method rather than the concept. Now it feels like [the representation] is there to support but lots of them are doing it mentally. I am not saying the ‘win’ is doing it mentally but being able to step back from it”**

#### **5. The potential to be mathematical is viewed differently**

Some participants discussed a shift in attitude about what they believe is success in mathematics. They described moving away the idea of a mathematician as someone who gets the correct answer or a high-test score, towards someone who can understand conceptually, make considered decisions about what appropriate method to apply, and has the skill and language to explain their reasoning. They state that they have become aware that young children (year 1) and lower attaining students are able to reason when given the resources, structure, and opportunity.

**“I remember thinking ‘What are my year 1 children going to do reasoning about?’ I was almost like I can see how you could get a year 6 student to reason but a year 1 child... But you realise that if you give them the language structure then they can reason, if you don’t what hope have they got, but the materials offer that structure and you have all these visuals that you can compare and talk about”**



## What has been the impact of the PD materials on other colleagues?

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The researcher asked the participants about how introducing the PD materials in their school had impacted on other colleagues. Three themes were identified.

### 1. Engagement with the materials led to consistency within the school setting

Participants stated that when colleagues engaged with the materials, this led to consistency in the teaching of mathematics. This was especially true when senior management understood and supported the principles found in the materials. The teachers talked about representations being standardised over different year groups and particularly the use of stem sentences, mathematics language, and representations in year 1, which they believed would prepare these students for later years. In addition, some participants considered the consistency of representations over the years groups as useful for children with SEN(D) or other additional needs as they move up the school:

**“I think it has helped to standardise certain imagery across the school ... when everyone is having to find their own images and representations you run the risk of a lack of continuity in them”**

One participant described the engagement of their Early Years colleagues in providing the opportunity for their students to experience representations and stem sentences, even though the materials start with year 1. Another participant stated having confidence that their TA would use the principles of the materials when covering teaching and learning as a result of them recognising the impact on students:

**“I have watched one of the lessons in Early Years and I think it was the number 8 ... they were making 8 in different ways and the children were talking about it and they were using the stem sentences”**

### 2. Subject knowledge has improved

Participants reported that the subject knowledge of their colleagues has improved. They described this in terms of maths as a subject as well as how to teach maths for understanding. They commented that colleagues are understanding the underlying structure of maths, recognising the ‘bigger picture’ and making links between how a topic is introduced in different year groups. They identify the importance of secure prior knowledge and the use of coherence, small steps to develop understanding:

**“Teacher subject knowledge has definitely improved, especially for teachers who are early in their career. I think they have got a much better understanding of the structure of addition, subtraction, multiplication and division; I think that is the biggest thing, that they are understanding”**

### 3. After some initial resistance, colleagues have come to value materials highly

Participants reported that when the materials were first introduced to colleagues, some could be overwhelmed by the amount of information, with concern about the time needed to read and understand the guidance. Additionally, they stated that some colleagues were concerned about going slower and using small steps due to the time pressures of the amount of National Curriculum content that needed to be covered. One participant described colleagues’ concerns about having to dispense with resources that had been used

in their previous teaching as well as issues around how to align the teaching points with their individual lesson plans:

**“I know that that has perhaps been a bit of an issue with other teachers beginning to use it, saying ‘it takes a long time’ or ‘there is not just a bank of worksheets’”**

Participants went on to say that over time there has been a positive change in mindset amongst their colleagues. They suggested that this was a result of seeing the change in students after consistent use of the elements of the materials in the classroom. Other elements mentioned as supporting a positive mindset were: time to reflect on consistent use of the resources; being able to use them for the second time; observing the use of the resources and student responses in a demonstration lesson delivered by the maths lead; and, 1-1 coaching on both how to access the materials and how to apply the guidance to a particular topic. One teacher comments:

**“Everyone carried on and by the end of the year everyone was a big fan, even some of the people who were most vocal about saying they don’t want to use them at the start were some of the biggest fans of it by the end. Once they had the time, they just needed the time and space to get to grips with it”**

One participant, whose school was using the materials in parallel with another scheme, reported that some colleagues’ use of the PD materials was inconsistent. Sometimes the reason given was concern about time pressures to cover content in existing schemes of learning. It was notable that in the cases where the materials were not used consistently, there were not the positive impacts on students reported by others.

## **How are the PD materials being used in school?**

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All of the participants are maths leads within their schools and with four out of five in their first year of Mastery Specialist training with the NCETM. As a result, all have engaged with the PD materials as part of a Maths Hub training process. The means by which the PD materials were used within the school of each participants varied. The research found five different ways that the materials are being used in school.

### **1. The materials are used for personal planning and delivery**

The participants stated that they use the materials in their personal planning, with the majority stating that they are used for planning most or every maths lesson as well as the sequence though a topic. The animated representations were highlighted as particularly useful for planning and delivery, as well as the stem sentences.

### **2. The materials are used to support an existing scheme of work**

In one case, the materials were used to support another published scheme of work that had been bought in by the school. On this occasion the materials were used as a means to fill in any gaps that are evident in the published resource rather than for everyday planning. As a consequence, the materials were used less frequently than for other participants – it seemed clear that this more ad hoc use of the materials did not bring the benefits observed in other schools (e.g., changes in students' reasoning and confidence).

### **3. The materials are introduced to colleagues on a whole school basis**

The materials were introduced to colleagues in a variety of ways with most using INSET and other staff meetings. Some participants presented the whole document to teachers of all year groups, elements of which should be trialled by colleagues before the full roll out in September 2020, whilst others concentrated on the most relevant spine for the current topic being taught. In some schools the materials have been provided to teachers of only a selection of year groups, for example year 1 and year 6. Additionally, some colleagues had the opportunity to comment and reflect on the use either in subsequent staff meetings or individually with the participant.

### **4. Elements of the materials are being used in demonstration lessons**

The materials were being used by the participants to demonstrate the resources, as part of lessons observed by colleagues. This was said to give the opportunity to highlight what should be included in a lesson, how to incorporate the representations and maths talk, as well as to showcase the impact on the outcomes and attitudes of students.

### **5. The materials are used for 1-1 coaching**

The materials were used on a 1-1 basis to coach and support the teaching of colleagues. The participants discussed providing support both in terms of how to access the materials and resources effectively, and how the resources can be used to promote understanding and close gaps in knowledge for students.

## **What are the key challenges reported in using the PD materials and how can they be overcome?**

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### **The researcher considered ongoing challenges reported by the participants in using the PD materials**

1. The materials take time to read and space is needed to understand the guidance, which is not always available in a busy school day. There is a lot of information in the guidance and teachers can initially feel overwhelmed. However, the structure of the materials soon becomes familiar and working together has been effective.
2. The practical aspects of accessing the guidance can be a barrier. This includes not having a search function for a particular subtopic, difficulties using the NCETM website, as well as the precise meaning of technical terms such as 'spine' and 'teaching point'. Some schools downloaded all of the materials to make them easier to access.
3. There is a mindset amongst some colleagues that concrete resources are for younger children only (KS1) and therefore the materials would not be appropriate. These can result in some teachers not engaging with the representations and concrete resources in KS2 classes, where they have an alternative. Commitment to using the spine as the basis for planning is a key and some, initially sceptical, teachers have been surprised by the benefits they observe.
4. The pressures of delivering the National Curriculum content in a timely fashion was of concern when considering the small, coherent steps - there was a need to recognise the fact that securing understanding now will support later work. Support from Senior Management in schools is vital.
5. The materials seemed less effective when used to support another scheme of work. This is a key finding from this research – the step changes in students' learning of mathematics occurred when the spines were the basis for planning across the school – and these changes were not observed if the spines were used in a more ad hoc manner.

## How was evidence gathered for this report?

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This report was created to give interested parties information about the use and impact on teachers and students of engaging with the NCETM Primary Mastery Professional Development materials. It was conducted by one of the members of the University of Bristol's, Mathematics Education Research Network.

The methodology used was a qualitative, grounded theory style approach which considered stories about the impact of using the Primary Mastery Professional Development materials for a small sample of teachers engaged in the Maths Hubs Teaching for Mastery programme. More specifically the areas of impact considered were:

- the learning experiences of pupils
- professional knowledge and practice of the lead teacher
- engagement with other teachers within the sphere of influence of the lead teacher

Data was collected using a face to face or a telephone interview depending on the geographical location of the participants, using contacts provided by the NCETM. All the contacts provided were from schools participating in the Teaching for Mastery Programme.. Between January and May 2020, the researcher contacted the teachers and interviews were arranged with five who had responded positively to the contact.

The recorded interview data was analysed to identify common themes that emerged from the stories of impact, using the areas mentioned above. The themes that emerged were identified as changes in: affect; actions; and, knowledge.

The aim has been to be to present an accurate description of the key themes found in the stories of impact. Clearly, the small scale, selective sample can only reveal the impact and experiences of these participants and a larger scale project is necessary to comment on the potential impact on a wider range of schools using the Professional Development materials. In addition, it is not possible to comment on the experiences of schools using the materials outside of engagement with the NCETM and the Maths Hub network.

With thanks to all of the teachers who agreed to be interviewed as well as the NCETM for their help. To contact the researcher, please email: [rachel.helme@bristol.ac.uk](mailto:rachel.helme@bristol.ac.uk).

Rachel Helme is currently doing her own PhD study with the University of Bristol.