Investigating the impact of 10 years of Maths Hubs: Negotiating the tensions between research finding and cause/effect connections sought by providers of professional development

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This paper is a part of a Knowledge Exchange project with a Maths Hub within the Midlands region of England. Maths Hubs are major providers of professional development (PD) for teachers of mathematics having been funded by the government for ten years. The aim of the project was to develop an understanding about how the impact of Maths Hub activities could be evaluated. We focused on NCETM Maths Mastery due to the pivotal role it plays in the hub activities. The theoretical framework developed for this study draws on the PD models of Guskey (2002) and Desimone (2009). Following a qualitative research design, data was collected through semi-structured interviews. Our initial findings show that knowledge and understanding about Maths Mastery vary considerably, even among those with long standing and substantial involvement with the Maths Hub. Moreover, assessing PD to identify concrete links with outcomes, as the providers sought, is problematic.

Keywords: Professional Development, Maths Hub, Mastery, Variation

Introduction

Maths Hubs were first introduced by the government ten years ago as a response to the relatively low ranking of England in international comparisons of attainment in mathematics. Currently, there are 40 regional Maths Hubs which are coordinated by the NCETM (National Centre for Excellence in the Teaching of Mathematics). The Maths Hubs programme brings together mathematics education professionals in a collaborative network, each locally led by schools that Ofsted classified as outstanding. In 2022, the NCETM reported that Maths Hubs were working with over half the schools in England. The core purpose of the Maths Hubs Programme, is to help schools and colleges lead improvement in mathematics education in England for the benefit of all pupils. They are part of the wider development of school-led system leadership in England (NCETM Maths Hubs, 2023).

Whilst Hubs have local autonomy to organise activities, funded courses are approved by the NCETM, the majority of which are part of national programmes. Maths Mastery and the Five Big Ideas (Coherence, Variation, Fluency, Mathematical Thinking, Representation and Structure) are NCETM's articulation of what constitutes good pedagogical practice, and these principles are intended to underpin most Maths Hub activities. Thus, by doing so they seem to be 'evangelising' the community of mathematics teachers to uphold what they consider 'good'.

The NCETM's diagrammatical form of the five big ideas (image below) was first published in 2017 and updated in 2022; summarising 'Teaching for Mastery, and the recommended pedagogical approaches.

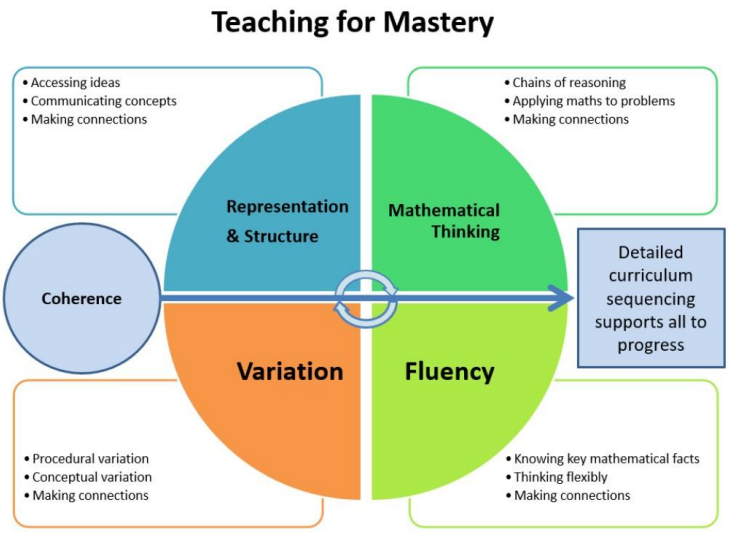

Figure 1 - NCETM Teaching for Mastery

In 2022, under the heading of the 'Essence of Mathematics Teaching for Mastery', the NCETM published underpinning principles, including key aspects of lesson design and classroom approaches; this includes:

- Learner: everyone can learn and enjoy mathematics; who reason and make connections.
- Teacher: develop specialist knowledge for teaching; work collaboratively to improve teaching.
- Curriculum: coherent content linked to prior learning so all can access; carefully sequenced steps; carefully selected examples to expose concepts and connections; fluency and concepts in tandem.
- Classrooms: whole-class interactive teaching, precise language; automaticity in key number facts; prompt identification of gaps in understanding, promptly addressed (NCETM, 2022, p.1).

This illustrates that there has been an ongoing evolution in how NCETM Maths Mastery ideas have been articulated and communicated. The NCETM also publish curriculum materials, including professional development resources, which schools can draw on independently. It should be noted, however, that there are curriculum materials published by other organisations under the banner of 'mastery', with the term used in different ways by different people.

Theoretical Framework

Drawing mainly on the work on teacher change by Guskey (2002) and the PD evaluation model of Desimone (2009), our model posits key components in teachers' professional learning. However, we agree with Coldwell and Simkins (2011) and others, who argue that the multifaceted, reflexive and dynamic nature of professional learning means that a linear model that implies a straightforward process-product relationship, with particular inputs resulting in specific changes, is both theoretically and empirically problematic. Within this complex system we are particularly interested in understanding connections between PD, teachers' practice and students' learning. Our model of professional learning identifies four key components: professional development activities; teachers' knowledge, beliefs and values; teachers' practice; and student experiences. These are all situated within the wider educational landscape of school organisations, regulatory and accountability frameworks.

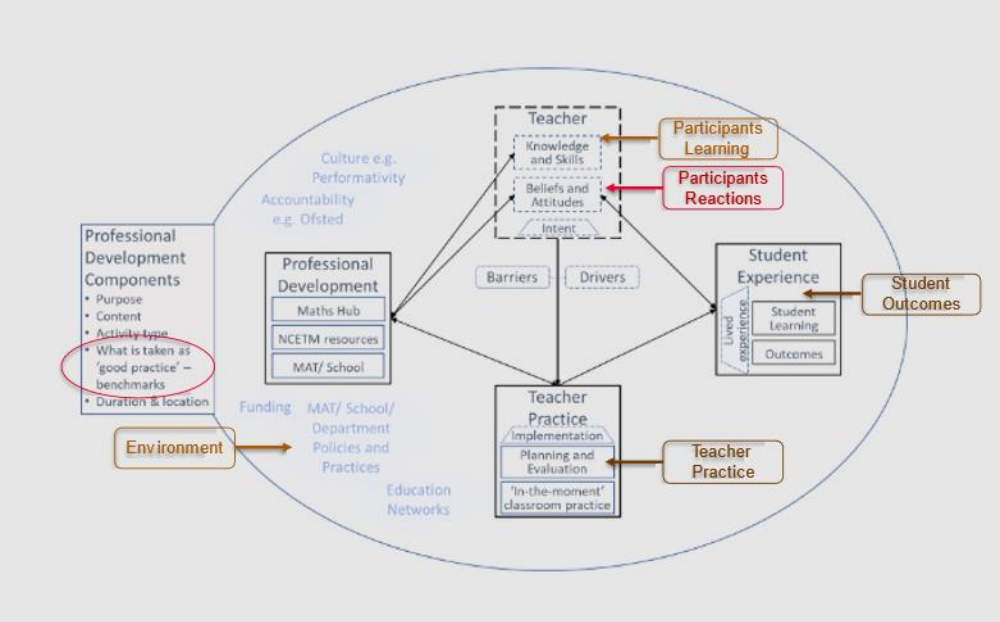

Figure 2 - Model of Professional Learning

Previous research indicates that many evaluation strategies focus on participants' reactions and their initial responses such as satisfaction or perceived usefulness. The Maths Hub's current evaluation strategies, that use Likert scale reporting and leaders' self-evaluation generally fall into this category.

Gaining access to evidence related to other components, as previous studies have also found, is more problematic but are the areas of interest. We have drawn on Guskey's (2002) classification of 'outcomes' to explore these connections (though we do not embrace a process/product relationship this term might usually evoke).

In terms of considering how successful implementation of the Maths Mastery approach has been, we adapted Proctor et al.'s taxonomy from the medical field (Proctor et al., 2011) which includes:

- Adoption: The initial intention to implement (uptake)
- Acceptability: Stakeholders' perceptions of the acceptability of the NCETM Mastery
- Appropriateness: Perception of fit (compatibility, relevance) to a particular context
- Cost: Including time and effort & what is not done because this approach is chosen.
- Feasibility: Extent to which mastery can be successfully implemented
- Fidelity: Degree of alignment with NCETM Maths Mastery
- Dispersion: Reach in terms of schools and staff
- Sustainability: The extent of maintenance and embeddedness in the curriculum

This taxonomy captures many elements of the strategic aims outlined by the Maths Hubs (e.g., dispersion, namely increasing the number of schools involved in Hubs and using the mastery approach). It also includes fidelity (discussed in findings), an area of interest to the NCETM who oversee Maths Hub activities, and are the authors of this particular version of Maths Mastery. It is also an area of contention: should fidelity be the aim for those working with/for Hubs, or should schools be encouraged to design their own approaches, drawing on elements of mastery as and when they feel it is appropriate?

Methodology

The overarching aim of this research was to develop a better understanding of the complexities involved in evaluating the impact of Maths Hub activities on teachers' practice and students' experiences. This allowed us to reflect on aspects of the current evaluation strategies of Maths Hubs and signpost some possible future directions. This research was based in the Midlands region of England and the participants comprised of teachers of Mathematics, PD session delegates and leaders and Maths Hub and NCETM employees. Many of the participants held multiple roles being teachers as well as performing different duties within the Maths Hub such as PD session leaders. A few participants had no direct links to Maths Hubs.

Following a convenience sampling technique, we recruited participants from both the primary and secondary sectors for the study through the EMS (East Midlands South) Maths Hub and professional contacts of the research team. Data collection consisted of 17 semi-structured interviews, most of which were conducted in person (14) but some were conducted online (3). Based on documentary analysis and our theoretical framework, the interview schedules were written to cater for different stake holders. The interviews were audio recorded, transcribed and analysed thematically with reference to the theoretical framework. A copy of the Five Big Ideas diagram was made available to prompt discussions if needed.

There are limitations for a study of this scale. This study does not claim to represent a complete analysis of EMS Maths Hub activities. The original intention was to observe multiple professional development sessions, but this was not possible due to delays in recruitment of research assistants. Thus, the focus shifted towards understanding the regional landscape in relation to Maths Mastery. We interviewed participants with different levels of engagement and contact within the Maths Hub. This variability provided a range of perspectives but the number of interviews and convenient participant recruitment means that whilst valuable insights have been found, claims of representation are not being made.

Findings

Variation in participants' definition of Maths Mastery

Initial analysis of the data indicates that all participants had some awareness of Maths Mastery, many of them developing it through their engagement in Maths Hub activities. However, it was interesting to note that there was considerable variation in their knowledge and perception of Maths Mastery, in particular NCETM Maths Mastery. A few had not seen the ‘NCETM Five Big Ideas’ diagram before whereas a couple talked about the five areas (Coherence, Variation, Fluency, Mathematical Thinking, Representation and Structure) without prompting. The participants explained and interpreted Maths Mastery in different ways. More than half the participants referred to more general principles, some of which aligned with the elements of ‘Essence for Mastery’ published by NCETM. Others alluded to the 5 big ideas often without articulating the link explicitly. For example:

> Participant 1: It's about developing consistent and small step coherent lessons for children to be able to grasp new concepts easily, making lessons, you know, accessible for all children…

Here, coherence, steps and accessibility for all, resonate with NCETM’s ‘Essence of Mastery’. However, ‘small’ is not an adjective NCETM used in ‘Essence

of Mastery' published in 2022 that uses 'carefully sequenced steps'; we noted that five out of six interviewees who mentioned 'steps' added the adjective 'small' or an equivalent that appears in earlier publications.

> Participant 2: … make sure they've got the basics and the fluency.
>
> Participant 3: A person that's mastered a topic can go here's how it fits into everything else that we've got, I think that's the important part, that that those links are formed…

These interviewees' descriptions of mastery included features that could be linked to aspects of NCETM Maths Mastery, such as fluency and making connections, but there was minimal coverage of the 'Big Five' or the 'Essence of Mastery'.

Participants' perceptions about implementing Maths Mastery principles and the degree of importance that should be attached with each of the Five Big Ideas also differed. For example, one interviewee stated that although the diagram presents four equal quadrants, they thought fluency was probably the most important. Whereas another indicated that, for them, coherence should be implemented as a priority. Out of the five big ideas, the most common unprompted comments related to fluency, and for those prompted with the Big Five diagram, fluency was the one most commonly related to their practice. However, as with the other ideas, how interviewees describe fluency varied. For example, one participant stated that 'fluency would be like how much you can recall things quite quickly, how much you can feel quite confident and secure …'. Whereas another participant maintained that there was more to 'true fluency' than 'just automaticity, rapid and accurate recall'. True fluency for this participant was 'being able to really work with those ideas in a flexible way…'

Fidelity: Degree of alignment with NCETM Maths Mastery

In this study, fidelity is taken as the degree to which we could match evidence to the mathematical principles as articulated by the NCETM. The aim, for some interviewees, was to implement NCETM Maths Mastery in its entirety and with fidelity, and indeed a few indicated that whilst they were still developing their understanding, Maths Mastery was fully embedded in their current practice. Whereas for others, fidelity to NCETM Maths Mastery was not a goal and they preferred selecting some elements to integrate with other curriculum choices.

Understanding the level of fidelity is an important factor for those seeking to evaluate the impact of Hub activities due to the pivotal role Maths Mastery plays. However, judgments about fidelity would require a reasonably consistent shared understanding of NCETM Maths Mastery, which is difficult to achieve. The term 'mastery' is used by different people across the sectors in different ways and the shear variety of routes to knowledge about NCETM Maths Mastery, from PD courses through to dissemination, almost enshrines variability. Maths Mastery is a complex and large field, and peoples understanding develops over time. For example, one interviewee stated 'my appreciation of fluency has grown over the years' and another discussed how their understanding of differentiation within Maths Mastery had changed. This variation in the understanding of NCETM Maths Mastery appears to extend to those who have had long-term engagements with Maths Hubs. The application to specific classroom practice adds another layer of complexity. Indeed, we found that interviewees tended to struggle when asked for specific examples to illustrate what a particular principle or idea might 'look like' in their classroom. There are also potential tensions that arise from school processes, such as performance

management. A few interviewees discussed how their teaching was judged by leadership's opinion about the degree to which practice aligned with the school's chosen approach, with little room for debate about what constituted good practice. Consequently, significant work would need to be undertaken to develop a reasonably consistent, shared understanding of Maths Mastery required to draw reliable and valid conclusions. These different facets illustrate the complexities involved in understanding fidelity of teachers' knowledge and practice, and ultimately student experience, in relation to NCETM Maths Mastery.

Conclusion

The understanding of NCETM Maths Mastery and 'The 5 Big Ideas' as articulated by our diverse participant group varied substantially. The differences in interpretation extended to those with longer term engagement with Maths Hubs. For some their goal appeared to be achieving fidelity with the NCETM mantra, whereas for others, mastery was viewed as a 'pick and mix' situation where they could incorporate selected elements into their current practice. The most common elements from the Five Big Ideas which were referred to and explained without prompting were fluency and variation. However, how these categories were understood and described varied. Explanations were rarely specific to identify how these ideas translated into particular classroom activity. Moreover, there are no simple evaluation protocols that could provide quantitative or qualitative measures of the impact of Maths Hub activities on teachers' practice or student outcomes. Assessing any PD is hard as there are so many factors involved. It appears that providers seek concrete links between PD courses and specific outcomes, which does not align well with the messiness and caveats involved in contingent findings that characterises academic research.

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