Understandings and perceptions of mastery approaches to mathematics: The case of beginning secondary teachers

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This study reports on the perceptions and understanding of beginning teachers regarding mastery approaches to teaching mathematics to 11–16-year-olds. It draws on qualitative data from six semi-structured interviews using vignettes designed to interrogate teachers' understanding of the features of mastery learning within their practice. The data were transcribed and analysed thematically, drawing on the literature in the field. Whilst capturing the full complexity of beginning teachers' perceptions and understanding is beyond the scope of this study, the data provides insight into these teachers' experiences at a time when mastery learning discourse is prominent in England. The study found that beginning teachers had different interpretations of the principles of mastery learning. It also found tensions between beginning teachers' beliefs, practice, professional knowledge and sense of agency in their developing classroom roles. Some beginning teachers found it challenging to talk about pedagogy and had continuing misconceptions about teaching and mastery approaches.

Keywords: secondary mathematics; mastery; beginning teachers, initial teacher education

Introduction and context

In this paper we are not advocating a model of teaching for mastery (NCETM, 2021) or mastery learning (Guskey, 2007). However, we acknowledge that pre-service teachers and early career teachers are aware of the use of the term in dialogue surrounding current policy (albeit not being stated directly in Department for Education National Curriculum documents) and practice in secondary schools in England. Our aim here is to interrogate beginning mathematics teachers' perceptions of mastery approaches to secondary classrooms, stimulating this interrogation through the use of vignettes that represent authentic extracts from previous beginning teachers' writing about teaching. We acknowledge that the use of the term 'mastery' is both commonplace and ambiguous (Boylan, 2020). This further stimulated our desire to give voice to beginning teachers' perceptions of mastery in mathematics teaching and learning because they are directly experiencing the consequences of this ambiguity.

Mastery in mathematics teaching

Our initial framework drew on Rycroft-Smith and Boylan's (2019) articulation of features of mastery alongside Guskey's interpretation of Bloom's theory of mastery learning (2007). The design of this framework acknowledges that features of mathematics teaching and learning aligned with notions of mastery have been embedded in mathematics education for beginning teachers for many years (see for example, ACME, 2015 and The Joint Mathematical Council for the United Kingdom, 2017). We drew on the literature (although a full exploration of the research that

informs the framework is beyond the scope of this paper) to develop the following framework for the purpose of capturing and then analysing the beginning teachers' perceptions. Our framework considers the features of mastery teaching to be:

- Teachers using evidence of ***pupils' prior knowledge and experience*** to inform lesson design;
- Pupils acquiring depth and ***meaning*** in their understanding of mathematics through ***reasoned connections*** and insight into ***structure;***
- Pupils being taught to make connections between different ***representations*** of mathematical knowledge and realisable ***contexts;***
- Teachers stimulating ***interactive dialogue*** that allows them to teach ***responsively;***
- Teachers embedding ***formative assessment*** into their teaching, explicitly using the pupils' responses to inform their actions in lesson design and teaching;
- Pupils ***memorising facts,*** making connections between structure, relationships and procedures;
- Teachers explicitly integrating assessment-informed ***intervention*** into lesson design and teaching;
- Teachers differentiating through ***enrichment*** and ***support;***
- Teachers carefully designing lessons that use ***variation*** in meaningful whole-class teaching.

Current interest in mastery learning reflected in English mathematics education policy (Department for Education and Gibb, 2016; NCETM, 2021) has been influenced by approaches to mathematics teaching in Shanghai and Singapore (Boylan, 2020). Aspects of learning mathematics such as reasoning from known facts, connecting multiple representations, variation and drawing pupils' attention to the object of learning are fundamental to teaching and learning mathematics, irrespective of whether these principles are taught as mastery learning or not (Marton, 2015). Our study is also of interest given the concerns expressed by Ofsted, a decade ago, that schools focus on examination results at "the expense of adequate understanding and mastery of mathematics" (2012, p.4) and the impact of a culture of performativity limiting teachers' ability to act upon their beliefs (Ball, 2003). Therefore, our analysis of the interviews with beginning secondary mathematics teachers has been situated within these cultural features alongside the analytical framework listed above.

Methodology

The research questions for the study were as follows:

- What aspects of mastery pedagogy do beginning secondary mathematics teachers recognise in their own practice and that of others?
- How do beginning teachers align and justify their beliefs with their practice?
- To what extent might their teaching reflect a mastery-type pedagogy?

The study took a qualitative and interpretivist approach in order to explore the perceptions and understandings of the interviewees. Data were collected through semi-structured interviews using vignettes defined as "written…stimuli…reflecting realistic and identifiable settings that resonate with participants with the purpose of provoking responses, including but not limited to beliefs, perceptions" (Skilling & Stylianides 2020, pp.542-3). Two vignettes were chosen; one adapted from a short excerpt from a student assignment and the other adapted from student reflective writing. A pilot study indicated that one such vignette was sufficient to stimulate a 30 minute interview. The vignette and supporting questions were designed to stimulate reflection, to help

participants articulate their beliefs about mathematics teaching and learning in relation to their classroom practice and to share their understanding of mastery approaches to mathematics teaching and learning. This approach is supported by Skilling and Stylianides' assertion that the vignette approach "can help capture participants' beliefs leading to a more nuanced understanding of the phenomena" (2020, p.541).

The teachers interviewed had completed their secondary mathematics Initial Teacher Education (ITE) post graduate programme at one of three universities and were interviewed by a lecturer from a different university approximately half way through their first year as a qualified teacher. Consenting participants were sent the vignettes and proposed questions in advance of the interview. The sample of teachers was diverse in terms of age, gender, ethnicity and additional needs. Interviews took place online, were recorded with consent, and then transcribed with the support of the online interview platform used.

Each researcher coded the transcripts independently using the previously-mentioned analytical framework. In addition, researchers sought to code and identify any additional themes emerging from the data. Meetings of the research team looked for cross-researcher comparisons and refinement of codes.

Findings

The data analysis identified 10 codes that were then grouped into four key themes, each containing between two and four of the codes (see Table 1). The six interviewees had different experiences and different levels of confidence in their practice; however, these themes were present in all the interviews.

Table 1: Key themes and codes

Key theme	Codes
Tensions	• Lack of confidence • Issues of equity for learners • Pupils wanting to 'be told' – and this is 'easier' to do • Lack of agency
Beliefs about teaching	• Constructivist • Own learning experience considered 'old-fashioned'
Professional practice	• Difficulties in articulating their understanding • Focus on a single aspect of practice
Myths about mastery approaches	• Everything in their ITE programme was about mastery • Mastery is unattainable in their setting

The following subsections contain indicative quotes for each key theme from the interview transcripts.

Tensions

> Student led teaching sounds amazing, but if they're not used to that then that's hard itself, cause they don't want to be wrong.

> The student-led again, the constructivist stuff, sounded fantastic in theory but I haven't seen a lot of it and I've not done a lot of it…as an NQT [Newly Qualified Teacher] I don't feel comfortable to design a lesson like that.

> Throughout all of it, you had to follow like 15 minutes doing this, 10 minutes doing this and that was like very like regimented how you had to teach.

Beliefs about teaching

> So even if you are doing simple things like fractions there's ways you can do it hands on, you can do bar models on a board still, so it can still be that you're stood at a board but you're showing it in different ways,….so it makes it more visual because again seeing it on a board and seeing it physically in front of you are two different ways to learn it again. And I do like the seeing it physically,

> I have a low ability year 9 class and even if I taught them a method, you could guarantee that literally the next day they would not know that method and would not answer.

> I'm trying to think back as well all the different ways that we were taught [on their ITE programme], lots of investigation.

Professional practice

> I have to say I'm not very good with the conceptual learning, but I think it's sort of like…it's not that you've memorised a method, it's that you fully understand how to do it. You could work backwards, you could be given a question that's the hardest thing to figure out how, why and what it wants you to find out but you'd be able to decipher that question and be able to find a maths skill you have to answer it.

Myths about mastery approaches

> I believe if you have spent quite a good amount of time on a topic and you've gone into depth about it and with experience, you would know what kind of misconceptions that might arise later on and you would, you know, cover that within the mastery teaching.

> We used like this teaching for mastery lessons that we got given … other years you're kind of following the approach of teaching for mastery but it's not said it's teaching for mastery.

> It could be a bit more time-consuming than the normal teaching.

Discussion

The interviews indicated that the beginning teachers felt tension between what they felt able to do in the classroom and what they felt they 'ought' to be doing. These tensions were often a consequence of their own lack of confidence and lack of agency when making pedagogical decisions. Some of our earlier (unpublished) work demonstrated that pre-service secondary mathematics teachers' beliefs right at the beginning of their ITE programme are aligned with the principles of mastery learning within a framework that is informed by constructivist and cognitivist principles of teaching and learning

mathematics inherent to the connectionist teacher orientation (Bruner, 2006; Tatto et al, 2012; Askew, 1999). Our interviews with beginning teachers indicated that they continued to hold these constructivist beliefs and were trying to reconcile what they had learned in their ITE with what they felt they could manage in school as a beginning teacher. These beginning teachers found it challenging to articulate their practice and when they did so, they tended to focus on a single aspect of practice. The transcripts indicate they had diverse understandings of mastery approaches to teaching with a range of personal interpretations, again often focusing on a single aspect of practice, for example, practical work, using representations or problem solving. Some saw such approaches as only for higher attaining or 'well-behaved' pupils and many saw these approaches as unattainable in their current context. Some believed that everything in their ITE programme had been about mastery.

What struck us was, in most cases, beginning teachers were clearly 'doing their best'. It was not that they didn't want to try using the types of approaches shown in Table 1. They had strong beliefs but lacked the confidence and agency in applying these principles to their classroom practice. At a time when they are negotiating their way through so many issues and worries it may be too much to expect beginning teachers to fully apply the principles stemming from their beliefs to their practice.

Japanese teacher educators believe that there are three levels of expertise in mathematics teaching:

- Level 1: the teacher can tell students the important basic ideas of mathematics using procedures and practices.
- Level 2: The teacher can explain the meanings and reasons for the important basic content and practices of mathematics in order for students to understand them.
- Level 3: The teacher can provide students with opportunities to understand mathematical content and develop mathematical practices, and support students to become independent learners.

They also believe that each level needs to be mastered before moving to the next and that it takes ten years and a great deal of effort for a teacher to reach level 3 (Fujii, 2014). Our findings support this view of mathematics teacher development given that the embedded use of a range of features of mastery teaching would be situated at level 3.

Conclusions

The work reported on here confirms our previous findings regarding the constructivist views held by pre-service secondary mathematics teachers but exposes differences in the interpretation of the principles of mastery learning in the settings where they learn to teach. It also identifies tensions that arise in beginning teachers' beliefs, practices, professional knowledge and sense of agency in their developing classroom roles. As ITE tutors, we are interested to consider how our findings develop our thinking about our work with pre-service teachers. We reflect on the differences between working with pre-service teachers and with in-service teachers where the former are not able to fully grasp that tutors are offering powerful ways of thinking about learners' mathematical development that point to ways forward in addressing common classroom dilemmas. We also find ourselves considering the power of small easy to implement interventions when working with pre-service teachers that could have a transformative effect in practice.

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