Mathematical knowledge in secondary mathematics teaching

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A story about MK in teaching

In his first school placement East, a PGCE student with a good mathematics first degree, taught two boys whose predicted GCSE grade is very low, and who are being schooled in Last Chance Saloon, a half-way house for students who would otherwise be excluded from school. East commented that he lost a grip on the difference between teaching these two boys and teaching an A-level group. This is because the quality of discussion he has with them is similar to that which he has with A-level students. For example, he had planned to teach them adding fractions, and decided to use the 'relevant' context of plumbing because one of them wanted to enter this trade. By the end of the lesson they were discussing what 0/0 could possibly be. A few sessions later they deduced the rules for indices from examples, and he then asked them what x would be if $10^x \times 10^x = 10$. They sorted this out in no time and also deduced that $10^{\frac{1}{2}}$ must be the square root. What East used for this was a deep connected understanding of mathematics beyond that which he was 'supposed' to be teaching them for much needed grade Cs. He also needed knowledge of ways to engage with mathematics – to reason within it; to construct new meanings by extension and exemplification. One could argue that the last thing he needed was any special curriculum knowledge, because that might have limited what he offered them.

East, and many like him, teach well because they know mathematics well, and the distinctions, orderings and limitations of the curriculum and of our expectations of learners are overridden by the strength of their own knowledge of mathematics and its modes of enquiry.

How can learning more maths impact on teaching?

The recent study in Auckland in which teachers were funded to pursue new-to-them mathematics courses showed further ways in which teachers' own mathematical studies can impact on practice:

- using their own new knowledge directly (e.g. history; explaining uses of simpler maths in higher maths and outside applications)
- knowing new connections (e.g. logs, indices, bases; graphs and modelling)
- knowing how to study (e.g. how to read text, exemplification, self-explanation, time, revision methods)
- new insights and approaches based more on structure and less on procedure (e.g. big ideas)

Unhelpful assumptions

Much literature about MKifT is based on questionable non-intuitive assumptions:

1. that the baseline is separate content and method courses and deficient teachers' textbooks– this is an inappropriate baseline for UK thinking

2. that teachers' knowledge is instrumental and procedural – most UK teachers have also 'done' coursework and investigative work

3. that teacher educators have specialist knowledge about M and MKifT

4. that the analysis required to teach is different from that needed to learn

5. that studying more maths on maths courses is unhelpful

6. that procedural knowledge can be 'unpacked' – you cannot unpack as empty suitcase; you can unpack past and present mathematical activity

Arguments for teachers learning more maths

Experience of learning mathematics is a good way to deepen and develop mathematical knowledge in and for teaching. I supported in my earlier paper by:

- Arguing against the use of typographies of MKifT
- Offering examples of curriculum difficulties which can be understood by analysing their mathematical components and affordances
- Arguing that understanding the activity of doing mathematics provides all the analytical tools needed to think about learning and teaching
- Avoiding pathologising learners and teachers by recognising inherent difficulties in mathematics
- Giving examples of teachers who are non-specialists and showing that what they do and do not do is dependent on personal subject knowledge
- Giving examples of teachers who studied more maths
- Showing how past and current learning can inform teaching.

Research questions – knowing more about MK in teaching

- How does MK act out in planning and teaching at secondary level?
- How do teachers whose mathematics teaching is good get to be that way?
- What is it that good non-specialist teachers do not do?

Research questions – MK in teacher education

- How do mathematics teacher educators in the UK teach?
- What is the mathematical background of mathematics teacher educators?
- What MK is required to be an effective mathematics teacher educator?