Developing confident primary mathematics teachers through school-based teacher-education

Rupert Knight posits a novel approach

I scanned the room and the sight was a familiar one: a sea of raised hands. I had just asked a new intake of primary student teachers whether anyone would own up to being particularly anxious about teaching mathematics. As in previous years, the response was striking.

This anecdotal illustration is, of course, borne out by well-known reports expressing concern about primary teachers’ subject knowledge, including the Williams Review (Williams, 2008) as well as research studies emphasising the related issues of confidence and affective factors (e.g. Henderson, 2012). In reality, however, the picture is complex. For example, perhaps counter-intuitively, John Hattie’s (2012) much-quoted meta-analysis of influences on pupil learning ranks ‘teacher subject matter knowledge’ 136th out of 150 influences examined, with a negligible effect size. Perhaps this is because subject knowledge is actually a multi-faceted concept. Shulman (1986) identifies, for example, curricular knowledge and Pedagogical Content Knowledge, in which subject matter, pedagogy and context are transformed into a new form of knowledge for teaching. If mathematical confidence, expertise, and knowledge in its broadest sense are our goal for beginning teachers, then consideration must be given to the best ways of fostering them. While this is a long-standing issue for all those working with both student and newly-qualified teachers, I would argue is a long-standing issue for all those working with both.

I wondered what this broader view of school-based ‘clinical’, with its medical connotations, is accepted, on enquiry, reasoning and judgement in a specific perspective: perhaps they have taught across the primary age range and have seen initiatives come together, might offer a valuable programme of subject knowledge development.

1. It’s not what you know, it’s who you know

With the relentless pace of daily life in school it can be easy to forget that this is a community rich in expertise. When novice teachers meet with colleagues, however, it is worth bearing in mind that they may still be ‘unconsciously incompetent’ to a certain extent and so being supported to ask the right questions is an important first step in scaffolding these conversations.

Mathematics subject leaders are an obvious first port of call. They have a valuable overview of curriculum and progression, a key facet of subject knowledge, as well as an awareness of colleagues who may be particularly worthy of observation. The subject leader may also be a source of information on new developments and useful resources. Newer teachers within school will have relatively recent insights and up-to-date guidance from their own training at a variety of providers and will be well-placed to share their own techniques for building up mathematical knowledge. More experienced staff members may offer a different perspective: perhaps they have taught across the primary age range and have seen initiatives come and go. What, for them, are the enduring principles underpinning effective mathematics teaching? What are the frequently-encountered misconceptions associated with particular topics and how might they be overcome?

A teacher’s professional network increasingly extends beyond the boundaries of any one school. A visit to the mathematics classrooms of a local secondary school could provide a useful top-up of personal subject matter knowledge as well as an insight into issues of progression. Further afield, in addition to their established role in ITE, many university schools of education offer opportunities for teachers to collaborate through curriculum development, newly-qualified teacher sessions, or other forms of focused professional development. Back at primary level, there may be a nearby school with a Specialist Leader of Education, a Mathematics Specialist Teacher, or simply someone known for their expertise and enthusiasm in this area; all would be excellent contacts. Finally, peer support can be powerful. If there are other beginning teachers locally, an informal study group may be mutually beneficial, with participants taking turns to act as tutor and tutee.
2. How did you do that?

Notwithstanding these wider opportunities, the fact remains that the classroom itself will be an important site for learning. Observation of more experienced teachers plays a central role in this and, rather than being seen merely as the prelude to the ‘real business’ of teaching, remains valuable at all stages of development, shifting in focus and purpose over time. If we are concerned, however, with deep understanding of the teaching of a subject and not just mimicry, then a fundamental problem exists: accessing the knowledge and decision-making of the observed teacher is notoriously difficult. As argued by Hagger and McIntyre (2006), much of a teacher’s knowledge is likely to be subtle, complex and tacit; subjecting another’s practice to a sustained critical examination requires a high degree of skill (quite apart from the issues arising from the inherent power imbalance). Novices, therefore, need to be helped to deconstruct what they have seen, and experienced teachers need to be ready and willing to articulate their thinking.

To take one example: observing just the opening twenty minutes of a lesson on formal algorithms for multiplication in Year Five, one might be able to draw out a wide range of issues concerning subject knowledge including:

- Pupils’ prior knowledge and how this has been ascertained.
- Where this method fits into the school’s progression of written methods.
- Is it building on the grid method or an expanded columnar method, for example and what are the implications in each case?
- The precise terminology used.
- The way the explanation or modelling is sequenced.
- The way that underlying concepts such as place value are reinforced.
- The links to mental strategies and good judgement about appropriate methods.
- The choice of calculations used.
- Is there a sense of progression?
- The likely misconceptions and common errors and how these have been anticipated.
- The range of questioning used and how this might promote higher-order thinking.
- The selection of resources and the ways in which they contribute to understanding.
- The teacher’s own fluency in using the method and how this has been developed over time.
- Is this a method they would use themselves?

A beginning teacher trying to make sense of a multitude of intractable issues, such as behaviour and assessment, may find it difficult to identify and attend to these particular subject-related points. A clear briefing beforehand and the development of focused criteria, such as those above, may be helpful in this respect.

More specifically, two devices might be considered as aids to this process of accessing teachers’ thought processes. The first is the use of video. The ability to capture another teacher’s lesson, or indeed one’s own for repeated viewing, ideally with the teacher present, offers many possibilities for detailed analysis. The second is the use of a team-teaching approach, as the middle ground between observation and independent enactment. Apart from the ‘safety net’ that this provides, its great contribution to subject knowledge development is the way in which it requires experienced teachers to plan collaboratively, to articulate the rationale for their decisions, and to clarify any points of subject-related confusion beforehand. The paired teaching itself might have a variety of forms and purposes. As can be seen from Table 1, much of this is about allowing the beginning teacher a narrower focus, or allowing the experienced teacher to intervene and prompt *legitimately*.

<table>
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<tr>
<th>Form</th>
<th>Subject knowledge development purpose</th>
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<tr>
<td>Divide the lesson into sections and take the lead at different times</td>
<td>Novice focuses on just one aspect of the topic in depth</td>
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<tr>
<td>Divide the class into two groups and take responsibility for one half each</td>
<td>Novice focuses closely on pupils’ learning on a smaller scale</td>
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<td>Work as a ‘double act’ alongside one another, as equal partners</td>
<td>Builds confidence and allows the experienced teacher to supplement the novice’s input legitimately where necessary</td>
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<tr>
<td>Use one person in role as a learner or devil’s advocate, to raise questions or misconceptions</td>
<td>Allows the experienced teacher to probe, question and challenge the novice’s input legitimately</td>
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<tr>
<td>Give one person the lead throughout, with the other in a well-defined subordinate role</td>
<td>Novice focuses on a limited skill, such as scribing a calculation or modelling an activity</td>
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Table 1: possible team teaching structures
3. Not just more of the same

It is easy for subject knowledge development to become a rather reactive process, based on a deficit model of identifying gaps or responding to forthcoming topics. As professionals, a sense of agency is important for new teachers and this raises the question of whether mathematical knowledge might be improved through a process of active enquiry. Small-scale enquiry has been found to benefit students in a number of ways, not least by promoting critical thinking and reflection (Medwell and Wray, 2014) and is one way of capitalising on the greater time spent in school. In this case, the value may lie as much in the confidence gained through closely examining an aspect of mathematics teaching as in directly improving practice. This process of enquiry could take on a collaborative form, perhaps even drawing on the model of Lesson Study, originating in Japan but now used internationally, with its emphasis on collegiality, research lessons, and case pupils.

Questions for exploration, focusing on subject-specific learning and pedagogy, may not be expressed in formal research terms and will frequently be impossible to answer with any great certainty, but nevertheless need a fairly tight focus. The outcomes of such enquiry need not necessarily be disseminated formally, as it is the process that is of most importance.

For example:

- How can concrete resources best be used to reinforce understanding of place value in Year One?
- To what extent does the use of an empty number-line help Year Three children to articulate their reasoning during calculations?
- What is the impact on pupils’ engagement of using real-life contexts in Year Six when exploring algebra?

Fundamentally, enquiring in this way and subjecting practice to scrutiny is about looking closely at mathematics, not only to improve basic understanding but also to question assumptions and to create a ‘need to know’. This disposition could also be promoted by exposing the beginning teacher to unfamiliar, or challenging, experiences in much the same way as we might seek to induce some form of cognitive conflict with pupils. Consider the potential impact of the following on a beginning teacher normally based in a Year Four classroom:

- Spending a day in a local special school seeing how pupils with autism make use of visual resources when learning mathematics.
- Visiting an early years classroom to see how the basic principles of counting are enacted in practice.
- Working with a group of gifted Year Six mathematicians on an open-ended investigation.
- Visiting Year Seven classrooms in the local secondary school for a morning, observing the progression of conceptual understanding from Key Stage Two.

In each of these cases, one might expect the new teacher to return with a broader understanding of the teaching of mathematics but also, more significantly, with many more questions to ask.

In all of the above, I am very conscious that this asks a great deal of teachers in school and those working with them. However, if we are to respond effectively to new models of entry into the profession, a shift of thinking and practice by all involved in Primary teacher education may be required. By interpreting subject knowledge in its broadest sense, I hope I have shown how school communities are full of exciting learning opportunities for the new teacher of mathematics; our task is to seek them out.

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References


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