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Introduction – Inside Naomi’s Classroom

In this chapter you will read about:

**the focus of the book on teachers’ knowledge;
the distinction between mathematical content knowledge and generic knowledge;
how teachers can develop knowledge for mathematics teaching;
a particular lesson on subtraction taught by a student teacher.**



This book is about some of the things that teachers know, that help them to teach mathematics well. There will be some ‘theory’, but most of the book is rooted firmly in real classrooms, with some teachers and pupils who helped to make the book possible. In fact, we shall visit one of these classrooms very soon.

Teachers are very serious about their work, and constantly want to get better at what they do. This improvement comes about through a variety of influences. You might want to pause a moment to think what these influences include, and list a few of them.

One obvious possibility is ‘experience’. We hope to get better at doing something simply by *doing* it. So we might imagine that our teaching of, say, mental addition strategies would be better in our second year of teaching than it was in the first, and so on. This may well be the case, although it is worth asking *why* it should, or what would help to make it

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more likely that it would. At the very least, you would need to be able to recall what you learned from your last experience of teaching mental addition strategies – what seemed to work well, and what did not. Fortunately, we learn a lot from things that do not go well, because we want to avoid them happening again. The key to all this is what is usually called ‘reflection’ on practice. Teachers’ open-mindedness and their desire to do a good job lead them to look for reasons for their actions in the classroom, and to analyse the educational consequences of those actions. Donald Schön’s term ‘reflective practitioner’ (Schön, 1983) is often used to conjure up the notion of teachers as professionals who learn from their own actions – and those of others. Schön distinguished between two kinds of reflection. The first, reflection *on* action, refers to thinking back on our actions after the event. Most of this book is about that kind of reflection, and we promote the idea that it is most fruitful to reflect on action with a supportive colleague who observed you teaching mathematics. The second kind of reflection is what Schön called reflection *in* action, being a kind of monitoring and self-regulation of our actions even as we perform them. This is also something that we think about in this book, especially in Chapter 6. Because reflection *in* action is especially difficult, a supportive observer can also be helpful in drawing attention to opportunities or issues that the teacher may have missed, often because their attention was on something more urgent. We should also point out, from the outset, that in observing and commenting on someone else teaching, the supportive observer stands to learn as much as, or more than, the one being observed. This book is witness to this claim. We could not have written it, and we would not have learned much of what we have to say in the book, without the benefit of a great deal of supportive observation of other teachers teaching mathematics. If we take any credit, it would be for our own efforts at reflection on other teachers’ actions in the past, and on and in our own teaching more recently.

In this spirit, then, this book offers you the opportunity to ‘observe’ other teachers and to reflect on what they do. Your observation may be fairly direct, because some lesson excerpts can be watched as video clips. Others will be ‘observed’ as you read succinct accounts of them and read some verbatim transcript selections. The advantage of the transcripts is that you can easily revisit and dissect them if you wish. With few exceptions, these teachers whom you will observe are relatively inexperienced, and their lessons are not offered as models for you to copy. You can read about why we videotaped these lessons in Chapter 2. Sometimes you will think that

a teacher could, or should, have done something differently. As we have already said, you will learn something merely by thinking that, and especially by making that reflection explicit in discussion, or in a written note of some kind. Paradoxically, you would learn very little from commenting that 'it went well'.

In the UK, many graduate student teachers (sometimes called 'trainees') follow a one-year, full-time course leading to a postgraduate certificate in education (PGCE) in a university education department. About half the year is spent teaching in a school under the guidance of a school-based mentor. All primary trainees are trained to be generalist teachers of the whole primary curriculum. The mathematics lessons featured in this book were filmed while the teachers were in their PGCE year or in the early stages of their teaching career. The index of teachers and lessons on p. 000 summarises where each teacher's lesson occurs in the book along with the career stage of the teacher, an indication of the mathematical content, the part of the lesson and, where appropriate, the video clip number on the companion website.

In this chapter, you will observe a lesson on subtraction. The pupils, boys and girls, are in Year 1 (age 5–6 years). The teacher is Naomi, who was, at the time, a PGCE student in the third and final term of her course. For most of that term, she was on a teaching placement in a primary school. Naomi chose to specialise in early years education in her PGCE. In most of the UK, it is usual to study only three or four subjects at school between 16 and 18. At school, Naomi had specialised in mathematics, English, French and psychology. Relatively few primary PGCE students have undertaken such advanced study in mathematics. Following school, Naomi's undergraduate degree study had been in philosophy.

In this book, we will sometimes ask you to read a description of a lesson, or part of a lesson. Sometimes we will give verbatim transcripts of short lesson episodes. In the case of the lesson featured in this chapter, you can also view a video clip (Clip 1) on the companion website if you wish.

Naomi's lesson

Naomi's classroom is bright and spacious, with a large, open, carpeted area. We can see around 20 young children in the class: there might be a

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few more off-camera. There is also a teaching assistant positioned among the children. The learning objectives stated in Naomi's lesson plan are: "To understand subtraction as "difference". For more able pupils, to find small differences by counting on. Vocabulary – *difference, how many more than, take away.*' Naomi notes in her plan that they have learnt *how many more than.*

Naomi settles the class in a rectangular formation around the edge of the carpet in front of her, then the lesson begins with a seven-minute oral and mental starter designed to practice number bonds to 10. A 'number bond hat' is passed from child to child until Naomi claps her hands. The child wearing the hat is then given a number between 0 and 10, and expected to state how many more are needed to make 10. Naomi chooses the numbers in turn: her sequence of starting numbers is 8, 5, 7, 4, 10, 8, 2, 1, 7, 3. When she chooses 8 the second time, it is Bill's turn. Bill rapidly answers 'two'. Next it is Owen's turn:

Naomi: Owen. Two.

(12 second pause while Owen counts his fingers)

Naomi: I've got 2. How many more to make 10?

Owen: (six seconds later) Eight.

Naomi: Good boy. (addressing the next child) One.

Child: (after 7 seconds of fluent finger counting) Nine.

Naomi: Good. Owen, what did you notice ... what did you say makes 10?

Owen: Um ... 4 ...

Naomi: You said 2 add 8. Bill, what did you say? I gave you 8.

Bill: (inaudible)

Naomi: 8 and 2, 2 and 8, it's the same thing.

Later, Naomi gives two numbers to the child with the number bond hat. The child must add them and say how many more are then needed to make 10.

The introduction to the main activity lasts nearly 20 minutes. She wants to introduce them to the idea of subtraction as difference, and the language that goes with it. To start with, she sets up various difference problems, in the context of frogs in two ponds. Magnetic 'frogs' are lined up on a board, in two neat rows. In the first problem, Naomi says that her pond has four frogs, and her neighbour's pond has two, as shown in Figure 1.1.

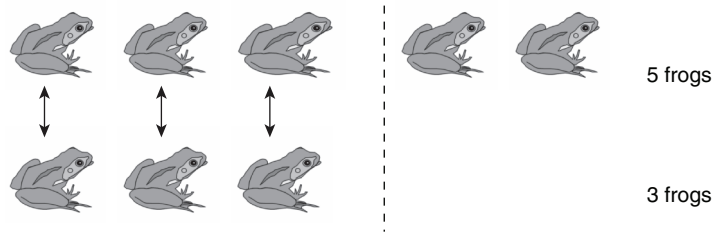


Figure 1.1 Naomi's representation of the frogs

Naomi: I went to my garden this weekend, and I've got a really nice pond in my garden, and when I looked I saw that I had ... [Naomi tries to stick some 'frogs' on the board] ... I don't think they're sticking. Let me get some blu-tack. It's supposed to be magnetic, but it doesn't seem to be sticking. Right. I had four frogs, so I was really pleased about that, but then my neighbour came over. She's got some frogs as well, but she's only got two. How many more frogs have I got? Martin?

Martin: Two.

Naomi: Two. So what's the difference between my pond and her pond in the number of frogs? Jeffrey.

Jeffrey: Um, um when he had a frog you only had two frogs.

Naomi: What's the difference in number? [...] this is my pond here, this line – that's what's in my pond, but this is what's in my neighbour's pond, Mr Brown's pond, he's got two. [Gender of neighbour has changed!] But I've got four, so, Martin said I've got two more than him. But we can say that another way. We can say the difference is two frogs. There's two. You can take these two and count on three, four, and I've got two extra.

Right, let's see who wants to be my helper.

A couple of minutes later, Naomi says:

Naomi: Morag's been sitting beautifully, oh no, Morag's been reading a poetry book. [...] That should be on my desk, thank you. Put your hand up please, you know the rule. Yes Hugh?

Hugh: You could both have three, if you give one to your neighbour.

Naomi: I could, that's a very good point, Hugh. I'm not going to do that today though. I'm just going to talk about the difference. Morag, if you had a pond, how many frogs would you like in it?

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Pairs of children are invited forward to choose numbers of frogs (e.g. 5, 4) and to place them on the board. The differences are then explained and discussed.

Before long, Naomi asks how these differences could be written as a 'take away sum'. With assistance, a girl, Zara, writes $5 - 4 = 1$. Later, Naomi shows how the difference between two numbers can be found by counting on from the smaller.

The children are then assigned their group tasks. The usual class practice is to group the children by 'ability' for mathematics. The actual numbers used in the difference problems are the same for each group, but the activity is differentiated by resource. One group (called the Whales), supported by a teaching assistant, has been given a worksheet on which drawings of cars, apples and the like are lined up on the page, as Naomi had done earlier with the frogs. Two further groups (Dolphins and Octopuses) have difference problems set in 'real life' scenarios, such as 'I have 8 sweets and you have 10 sweets'. These two groups are directed to use multilink plastic cubes to solve them, lining them up and pairing them, as Naomi had done with the 'frogs' in her demonstration. The remaining two groups have a similar problem sheet, but are directed to use the counting-on method to find the differences. Naomi works with individuals.

In the event, the children in the Dolphin and Octopus groups experience some difficulty working with the multilink. This is partly because 'lining up' requires some manual dexterity, and also because the children find more interesting (for them) things to do with the interlocking cubes. Naomi comes over to help them. She emphasises putting eight cubes in a row, then ten. 'Then you can *see* what the difference is.' She demonstrates again, but none of the children seems to be copying her. Jared can be seen moving the multilink cubes around the table, apparently aimlessly. Another child says 'I don't know what to do'. Naomi moves away to give her attention to the Dolphins and Octopuses. In her absence from the table, one boy sets about building a tower with the cubes. Later, Naomi returns to the Dolphins, and tries once again to clarify the multilink method. She asks: 'What's the difference between 7 and 12?' Without looking up, the boy who is making the tower replies 'Don't ask me, I'm too busy building'. Naomi responds by saying 'Goodness me, let's put these away. I'll show you a different way to do it.' She collects up the multilink cubes into a tray, and takes the Dolphins and Octopuses back to the carpet, where she shows them the counting up strategy for the difference

between 8 and 10. 'You start with the lower number ... you start with the smallest number. Count on – show me your first – 9, 10.' She then works through the first three worksheet questions, doing them for the children, by counting up.

Finally, Naomi calls the class together on the carpet for an eight-minute plenary, in which she uses two large foam 1–6 dice to generate two numbers, asking the children for the difference each time. Their answers indicate that there is some confusion among the children about the meaning of 'difference'.

Naomi: Right, I'm going to roll the dice, and I want you to find the difference between the two numbers. 5 and 3. Now starting with the smaller number can you count up to see what the difference is. [...] I can show it with the frogs as well. Jeffrey, can you have a go at working it out? The difference between 3 and 5.

Jeffrey: Seven.

Naomi: No, we're starting with 3 ...

Jeffrey: Eight.

Naomi: and counting up to 5. What's the difference? It's like a take away sum. Stuart.

Stuart: Two.

Naomi: Excellent. Can you tell us how you worked it out? Come to the front. Owen stand up. Sit in your rows please. Right, Stuart just worked out the difference between 3 and 5 and said it was 2. How did you work it out? Stuart.

Stuart: I held out three fingers and five and then there's two left.

Naomi: Ah, OK. That *does* work because you've got five fingers on your hands so if you've got five here and three you've got two left to make five. But I know an even *better* way to work it out. Does anybody know another way to work it out? Ayesha. No. Who knows another way to work it out? Leo.

Leo: Count in your head ...

Naomi: Yeah, how did you count? What did you count in your head?

Leo: I thought of 3 ...

Naomi: Jeffrey stand up, Hugh stand up!

Leo: Then I added 2. But I still had 2 left.

Naomi: Right, started with, started with 3, did you say, and then you counted on 2, 'till you got 5. Right, let's see what we get next. Who can do this one for me? 3 and 6. 3 and 6. What's the difference between 3 and 6? Jim.

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The plenary continues in this way, and finishes with:

Naomi: What is the difference between 4 and 6? So hold the number 4 in your head and count on. 4, 5, 6. What's the difference? Jared?

Jared: Uh, can't remember.

Naomi: The difference between 4 and 6. Jeffrey?

Jeffrey: Two.

Naomi: Good boy. Right, the difference between 2 and 4? What's the difference? So start with the smaller number, 2 and count up 'till you get to 4. What's the difference?

The one-hour videotape ran out here, just before the conclusion of the lesson.

Reflecting on Naomi's lesson

You should now have a good sense of what Naomi was trying to achieve in her lesson, how she intended to go about it, and how things turned out. You might feel that you 'know' Naomi a little, or someone like her. You might recognise some of the children in her class, in that they remind you of children that you have taught or seen in other classes.

At this point we would like you to do some thinking about Naomi's lesson. You *can* do this on your own. Better still, discuss it with a friend, colleague, another student or small group of students, according to your circumstances at the moment. Have ready a piece of paper to write on, a whiteboard, or a flipchart – whatever suits those circumstances. Think and talk about *anything that came to your attention* as you read the account of the lesson, and/or watched the video clips. Later in the book, we will ask you to focus on specific aspects of this and other lessons. For the moment, we leave it to you to make the choice. You might imagine that you are Naomi's friend, or her mentor, and that she is expecting you to offer her some comments on the lesson.

Once you have begun to think and talk about particular aspects of the lesson, make a note of what they are – write a brief statement of what it is that you are thinking about, and what people are saying.

Magnetic frogs. like fridge magnets. Have seen something like this used before - magnetic numbers on a 1-100 square, but they kept falling off! Seems that Naomi had the same problem. Issue of resources that won't distract from intended purpose because they don't work. Naomi resorted to blu-tack. She could have checked the magnets before the lesson.

Figure 1.2 A note about Naomi's lesson

For example, you might write something such as the notes in Figure 1.2. This is not meant to be a particularly good example of the notes that you might write. It isn't particularly bad, either. It's just an example of the kind of thing that you might discuss and how you could record it briefly.

You could spend a long time thinking about Naomi's lesson, but we suggest about 20–30 minutes.

Now group the issues that you've chosen to focus on into a small number of *categories*. The issues in each category will have something in common. What that 'something' is is entirely up to you. There are no right and wrong categories. Give a short *name* to each category. Don't spend too long on this. If you are in a class situation, and several pairs or groups are also doing this exercise, it will be valuable and interesting to compare the categories that different pairs or groups come up with.

Then make a note of anything that your reflections and discussion have *particularly* highlighted for you. Perhaps something you might not have noticed on

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(Continued)

your own. Perhaps something you think is a key issue for this topic, or for teaching generally. Perhaps something to keep in mind when you prepare a lesson, or when you teach a class, in the future. This could be at various possible levels – preparing or teaching *any* lesson, or a mathematics lesson, or a Year 1 lesson, or a lesson on subtraction, or ...

[Here there will be at least a page-turn to separate the above from what follows]

Naomi's lesson – our reflections

We want to offer some ideas of our own about Naomi's lesson. We emphasise now, and will repeat again and again in the book, that these are not in any sense 'the answers' to our earlier questions! Some of the issues or questions that we raise might be matters that you considered earlier in your own reflections and discussions. Others might not have occurred to you, or might seem to you to be rather unimportant. We might even agree with you on this last point, but we are trying hard to be open to a wide range of possibilities. Finally, you will almost certainly have considered issues that we do not raise here, and that may well be because they haven't come to our notice. If they had, the book might be different in some particulars. In this sense, we repeat, the following suggestions are not the only answers to our questions.

So here is a list of a dozen things that came to our attention.

- 1 Was Naomi's teaching brisk, did it have good pace?
- 2 What is meant by 'subtraction as difference'? What other kinds of subtraction are there?
- 3 Was it a good idea to use the number bond hat in the oral and mental starter?
- 4 Does Naomi use the 'frogs' in a way that helps the children to understand the 'difference' notion of subtraction?
- 5 Is there a lesson plan for this topic on the internet?

- 6 Does Naomi use mathematical vocabulary in a helpful way? Are the children learning to use it?
- 7 Should Naomi have given more attention to the Whales when they were working with the teaching assistant?
- 8 How does Naomi deal with the ideas put forward by the children (e.g. Hugh's idea about having three frogs each)?
- 9 Did Naomi spend too much time on the oral and mental starter?
- 10 Why did Naomi chose that particular sequence of numbers (8, 5, 7, ...) in the oral and mental starter?
- 11 Which suppliers can you get magnetic animals (and other fridge magnets) from?
- 12 Were the differentiated group activities well chosen? What principles, beliefs or theories about learning might have underpinned them?

These are all relevant to Naomi's teaching, and to her development as a teacher. Because Naomi was on a PGCE school-based placement, she would get regular feedback on her teaching, in written notes and discussions, from her class teacher – her mentor – and other experienced teachers, as well as from her university tutor. All of the issues raised in the questions above could usefully be considered in a review discussion of the lesson. We deliberately listed one or two – like issue 11 above – that were intended to be less important. But 'importance' involves value judgement: issue 11 is not at all frivolous if you are due to teach this topic later in the term and you want to use that equipment!

The fact that all of the 12 issues in our list *could* usefully be considered in a review discussion does not mean that all of them *should* be discussed with Naomi after the lesson. It is quite useful to be selective, so that you can focus on and think deeply about just a few things in detail. The same would be true of Naomi in the post-lesson review discussion. An attempt to think about too many different things, in a limited time, can lead to information overload. It might be *possible* to advise Naomi about ten things that she should do differently another time, but she would then be likely to be overwhelmed (and perhaps depressed!) by the effort to keep it all in mind. If, on this occasion, you choose not to reflect on Naomi's handling

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of the children's comments (point 8) it will not be the end of the world. The same would be true for Naomi's lesson review. However, we do want to draw out here one possible outcome when you grouped your issues into categories in the earlier task.

Issues for reflection and discussion: a key distinction

If we were to put the 12 issues that we listed above into categories, as we asked you to do, we would start with two. One category singles out those issues that are *content-specific*. By that, we mean that they are specific to the subject being taught – mathematics in this case. The other is those that are not content-specific, sometimes called *generic* issues, that would be pertinent whatever subject was being taught. We appreciate that one of the characteristics of the primary school curriculum is that subject boundaries are sometimes blurred, often deliberately so. Nevertheless, we are likely to agree that Naomi is primarily teaching mathematics in this lesson, although she is also teaching literacy, personal and social education, and so on. Generic issues include, for example, those to do with the management of behaviour in the lesson, general aspects of the management of learning (such as ability grouping), general assessment frameworks, and so on.

Again, we appreciate that these categories are all fuzzy at the edges. For example, we would say that quotes 1 in our list, 'Was Naomi's teaching brisk, did it have good pace?', is an example of a *generic* issue – pacing the teaching well, so that children are stimulated and on-task. It would be an issue in the teaching of any subject. However, we also recognise that getting the balance, between lively interaction *and* giving children time to think and to articulate their thoughts, is particularly delicate in mathematics teaching (Sangster, 2007). Nevertheless, we stand by our *content-specific versus generic* distinction for the time being. We would claim, and think that few would dispute, that quotes 2, 'What is meant by "subtraction as difference"? What other kinds of subtraction are there?', is very clearly a *content-specific* issue. Subtraction is a mathematical operation and a mathematical concept. The question would make no sense at all in the context of a history lesson.

Research has shown (Strong and Baron, 2004) that the vast majority of mentors' comments on lessons that they observe are generic in nature. Very little is said about the actual content being taught. That is one reason

why we have written this book. In order to develop mathematics teaching, it is necessary to think about the subject-matter being taught, as well as the more generic issues. The research therefore suggests that ways of thinking about and discussing the content of lessons are needed. Our own research into classroom mathematics teaching led us to develop such a way. It is based on a framework of categories for thinking about teaching – the *knowledge quartet*. You will read about this framework, and how it came about, in Chapter 2.

The odd-numbered questions 1, 3, 5, ..., 11 above are intended to be examples of generic issues that relate to the lesson being observed, whereas the even-numbered 2, 4, 6, ..., 12 are intended to be content-specific. We are more confident about the second category (the even ones) than the first. We recognise, for example, that an on-line unit plan (question 5) is highly relevant to the teaching of this particular mathematical content. What the content of such an off-the-shelf plan would not reveal, however, is anything about Naomi's own knowledge about subtraction and how to teach it. This *knowledge base* is a key factor in what this book is about, as will become apparent in the next chapter.

Teacher knowledge

The theme of *teacher knowledge* will be apparent throughout this book, and we begin to develop it in Chapter 2.

One would expect teachers to be knowledgeable about their work. One of the most important ways teaching is improved and developed is by developing *knowledge* about teaching and learning. This book is about ways of building up your knowledge about mathematics and mathematics teaching. It is structured around *reflection on classroom situations*, and in this way we are trying to complement, not to duplicate, what other primary mathematics books for teachers already do very well. We mention some of them at the end of this chapter.

As we have already said, Naomi needs knowledge about subtraction *and* how to teach subtraction. These are two different kinds of knowledge, although sometimes it is difficult to separate teachers' own 'learner knowledge' – what they needed to pass school exams – from the 'teacher knowledge' that they need to help someone else to learn. One aspect of

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this, which we revisit in Chapter 2, is the distinction between the *common content knowledge* of educated citizens on the one hand, and teachers' *specialised content knowledge* on the other. Naomi's everyday 'learner knowledge' about subtraction can, to a very large extent, be taken for granted. We do not doubt that she is able to perform whole number subtraction faultlessly. However, as we shall explain in Chapter 7, Naomi's fundamental conceptual understanding of the nature of subtraction as an operation may well be partial. This is no criticism of Naomi: the 'specialised' professional knowledge that she may not be aware of is not explicitly assessed in mathematics exams.

The way that people talk about teachers' 'teacher knowledge' (sometimes called pedagogical knowledge) conveys something of their beliefs about how people learn. Some people talk about skilful teachers being able to 'pass on' or 'put across' what they know. This is an enviable talent, but to describe it in this way conveys the notion of knowledge as a kind of commodity to be passed on to, or shared with, others. Teaching would then be associated with very careful explanations of what the teacher knows as part of their own learner knowledge. The expectation would be that the learner then acquires a kind of copy of what the teacher knows. It means that the mathematical behaviours of learners would mimic those of their teachers – most obviously, they would perform calculations in more or less identical ways. This amounts to looking at teaching as a process of *transmission*, and is in keeping with *behaviourist* theories of learning, which have their roots in the psychology of Thorndike (1922) and, more recently, Skinner (1974).

Over the last thirty or forty years, it has become more usual for teachers (though not necessarily for the public at large) to think about learning in a way that attributes greater autonomy to the *learner*, who is seen to play a more *active* part in learning than merely accepting what the teacher 'passes on' or 'hands down' to them. Children are viewed as not only receiving knowledge, but also actually *constructing* it for themselves. The role of the teacher is then reconceived from mere 'telling' (although there is always a place for that) to providing and initiating tasks and activities for the children, and to skilful management of group and class discussion to make sense of these tasks. What we are calling 'teacher knowledge' therefore does include knowing about how to explain things in helpful ways, but it also includes how to design tasks for learning, how to stimulate reflection, and to orchestrate discussion.

Teachers' knowledge resources

Every teacher has a wealth of learner knowledge *and* teacher knowledge, which they bring to their work as a teacher. Within a school context, this knowledge resource is both *individual* – what each teacher knows – and *collective* – what is accessible by reference to colleagues.

Both are important. Individual teachers draw on their own resources, and on their colleagues, at different times. In a group planning session, collective knowledge is paramount. In dealing with a child's spontaneous question in the classroom, individual knowledge is likely to be the first resort. This book aims to build up your individual knowledge base, encouraging you to draw on collective knowledge resources whenever possible.

When you reflect on the lesson excerpts presented in this book, or watch the online video clips, or when you reflect on your own teaching, questions and dilemmas will surface that make demands on your professional mathematics knowledge base. In many instances, you will be aware that some aspect of mathematics knowledge (either learner or teacher knowledge) has been significant in a particular episode – either because it was used to good effect, or because it seemed to be overlooked by the teacher in that episode. In other cases, you will not be aware in the same way, or to the same extent. As one beginning teacher recently said to us, 'You don't know what you don't know'. For example, in Chapter 7 an account will be given of a teacher teaching counting to young children. Of course, she knows how to count herself! But it is also evident (from her actions and from a discussion after the lesson) that she knows, and she knows that she knows, some important theoretical principles that underpin the teaching and learning of counting. As it happens, she learned them in a lecture on her PGCE course, but she might have read about them in a number of books (e.g. Maclellan, 1997), or a colleague might have brought them to her attention. The fact that she knew these principles enhanced her teaching. But if she had not known them, she wouldn't 'know what she didn't know'. For that reason, we will offer a few comments of our own on the lesson excerpts in this book. Joint reflection with a colleague or mentor is also valuable because the 'team' can pool their knowledge in discussion – a case of the collective knowledge that we described earlier. We also sometimes point out where other authors have explained some of what there is to be known about the teaching and learning of the relevant mathematics.



Summary

In this chapter, we argued that teachers can develop their mathematics teaching by focused reflection on their own classroom practice and that of others. Rather than thinking about some rather generalised notion of how you teach, most benefit is to be gained by reflection on *actual episodes* from lessons you or others have taught. We gave a first illustration of how this can work with a visit to a lesson taught by a student teacher, Naomi, and we asked you to identify issues from her lesson for further consideration.

We made a key distinction between *content-specific* issues – specific to the subject being taught – and *generic* issues that would be pertinent whatever subject was being taught. We emphasised that this book will focus on issues *specific to the mathematics being taught* in Naomi's lesson, in your own lessons and those of your colleagues, and in many lessons to come later in the book. We also emphasised that our focus, and the ambition of the book, is to build up the knowledge that underpins effective mathematics teaching. The book is structured around a framework for analysing and reflecting on mathematics teaching. The framework is called the *knowledge quartet*. In the next chapter you will find out what the knowledge quartet is, and how it came about. This will be essential reading in order for you to understand and benefit from the rest of the book.

Further reading

We conclude this chapter with a selection of the kinds of books that you may find useful as a companion to this one. Their content, structure and style differs, but there should be at least one that you find approachable and helpful.

Julia Anghileri (2006) *Teaching Number Sense*, 2nd edn. London: Continuum.

Julia Anghileri (2008) *Developing Number Sense*, London: Continuum.

Julia Anghileri is a leading researcher and writer in the field of children's arithmetic, and her authoritative and very readable books draw extensively on research in the UK, the Netherlands and the USA. The first of these focuses on the primary years, up to about age 10, the second straddles primary and middle years (ages about 9–13).

Derek Haylock (2006) *Mathematics Explained for Primary Teachers*, 3rd edn. London: Sage.

Derek Haylock has a talent for lucid explanation, and the book offers a very clear and supportive introduction to primary mathematics pedagogy. Tens of thousands of

student teachers have used and found reassurance in this book over the years. The most recent editions are more explicit in their reference to research findings.

Jennifer Suggate, Andrew Davis and Maria Goulding (2006) *Mathematical Knowledge for Primary Teachers*. London: David Fulton.

This very accessible text is also ideal for trainee and serving teachers who are lack confidence in their own knowledge of mathematics. The emphasis throughout is on understanding and making connections between topics.

Ian Thompson (ed.) (1997) *Teaching and Learning Early Number*. Buckingham: Open University Press.

This is not (just) for early years teachers. Understanding how children learn number concepts and operations has been radically affected by recent research in the Netherlands, the USA and the UK. This book is a very readable summary of that research, with implications for classroom practice.

Ian Thompson (ed.) (1999) *Issues in Teaching Numeracy in Primary Schools*. Buckingham: Open University Press.

Ian Thompson (ed.) (2003c) *Enhancing Primary Mathematics*. Maidenhead: Open University Press.

These two books are as readers in primary mathematics education, with contributions from a number of individuals who have influenced policy in the UK.

Louise O'Sullivan, Andrew Harris, Margaret Sangster, Jon Wild, Gina Donaldson and Gill Bottle (2005) *Reflective Reader: Primary Mathematics*. Exeter: Learning Matters.

This slim, approachable book sets out to introduce 'challenging and topical theory' in primary mathematics education to beginning teachers. This firmly relates to what we call 'foundation knowledge' (see Chapters 2 and 7), and is very much in keeping with the emphasis on reflection in this book.

Linda Dickson, Margaret Brown and Olwen Gibson (1984) *Children Learning Mathematics*. Eastbourne: Holt Education.

Marilyn Nickson (2000) *Teaching and Learning Mathematics: A Teacher's Guide to Recent Research*. London: Cassell.

The first of these is a classic and unrivalled popular guide to research findings in mathematics education. You may still find reasonably priced, used copies online. Marilyn Nickson's book is perhaps a little less user-friendly than Dickson et al., but her research update has an international flavour, and has been well received.