DEVELOPING MATHEMATICS TEACHING AND TEACHERS

A Research Monograph

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CHAPTER 4:

Continuing Professional Development in Mathematics Teaching

This chapter considers the development of mathematics teaching through teachers' ongoing in-service professional development. The focus of the chapter is on past and present events and developments within the UK, some reference to research and practice elsewhere establishes a link with subsequent chapters. There is a great deal to be told and to be known about a plethora of UK mathematics in-service initiatives over several decades, yet remarkably little systematic study, evaluation and reflection - what might legitimately be called research - to report. The character of this chapter is therefore principally (but not entirely) historical and descriptive. Where possible, we draw out here what has been learned from these initiatives. Some ways of reflecting on these lessons are introduced in subsequent chapters

4 CONTINUING PROFESSIONAL DEVELOPMENT IN MATHEMATICS TEACHING

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Introduction

The need to update and refine professional knowledge throughout their careers has been particularly acute for mathematics teachers since the 1960s, in response to curricular reform, new perspectives on learning and teaching, new technologies and innovations in assessment in all phases of education. Agents foremost in the provision of In-service Education and Training (INSET) have been HEIs, LEAs and Professional Associations, notably the ATM and MA. Mathematics teaching development has also been an intentional dimension of major curriculum development projects such as the School Mathematics Project (SMP), Nuffield Primary Mathematics, Primary Initiatives in Mathematics Education (PrIME), the Raising Achievement in Mathematics Project (RAMP), and the National Numeracy Project 1996-99, which preceded the introduction of the National Numeracy Strategy (NNS). Central government together with various charitable trusts and publishers have provided the funding for these and other initiatives.

1982 saw the publication of the Cockcroft Report (DES, 1982), a landmark report of a three-year government inquiry into the teaching of mathematics in schools. On outcome of the report was the appointment of significant numbers of additional advisory mathematics teachers – so-called 'Cockcroft missionaries' – to LEAs. Nolder and Tytherleigh (1990) give a rare research-focused account of a collaborative curriculum development and INSET initiative between LEA advisory staff and a group of 15 committed secondary teachers. The privatisation characteristic of government education policy since the 1980s (Harland, Kinder, and Keys, 1993) has encouraged significant numbers of independent consultants and agencies to enter the field. From a peak in the mid-late 1980s, the role of HEIs in INSET has declined significantly. A number of former LEA advisory staff have joined the ranks of the independent providers, and many schools have been attracted to a model of self-help, 'school centred' INSET. In a wide-ranging, government-commissioned review of evidence of teaching methods and classroom practices, Alexander, Rose and

Woodhead (1992) stressed the importance of a "mixed economy" INSET, drawing on professional resources within and beyond the school. Their report cautioned that "school-based INSET pursued as the only in-service strategy … may result in some schools merely recycling their own inadequacies" (p. 53).

Since the mid-1990s, the term 'INSET' has given way to 'Continuing Professional Development' (CPD) in official discourse. The fragmented nature of the evidence base regarding the effectiveness of CPD programmes is acute. Furthermore, it is unclear what, if anything, is distinctive about the development of *mathematics* teaching in particular (as opposed to the teaching of any other subject). Nor is there clarity concerning the particular CPD needs of secondary mathematics teachers, as against primary teachers. Few UK in-service education providers seem to have been concerned to research their CPD provision. The more accessible reports of curriculum development projects such as PrIME (Shuard, Walsh, Goodwin, and Worcester, 1991) tend to be strong on the rhetoric of success and weak on objective, systematic evaluation of their impact on teachers or pupils. In any case, there are few studies relating specifically to mathematics and the effects of mathematics training programmes. Indeed research on the effects of INSET programmes, *per se*, has been described by Halpin, Croll and Redman. (1990, p. 164) as "meagre" and lacking a "cumulative dimension".

CPD and Change

While one purpose of CPD might be to update teachers' knowledge – of legislation, curricula or resources for example – the objective of many CPD initiatives has been to bring about some kind of 'change' in teachers themselves. The direction of any such intended change necessarily follows from a judgement by someone or some body about one kind of teaching practice being, in some sense, preferable to another. Such a judgement may or may not be evidence-based, and it might not be universally accepted that the proposed change will be for the better. Aspects of educational policy determined by the uninformed preference of a single government minister is not unknown in the UK (see e.g. Rowland, 1999, pp. 178-9).

In any case, change is a complex and unpredictable process. The director of one mathematics teacher development project in the 1980s wrote "Effective [teacher] change will take time and effort. There are no short cuts" (Ahmed, 1987, p. 36). More recently, the external evaluators of the National Numeracy Strategy (NNS) have concluded that bringing about change is "Hard Work – Intellectually and Emotionally" (Earl, Fullan, Leithwood, and Watson, 2000, p. 39). This conclusion is supported by a study in the USA (Clarke, 1997) of two lower-secondary teachers in the same school with similar professional support networks who were involved in a long-term and intensive programme of professional development. One teacher's practice changed significantly, whilst the other teacher's practice did not change. Clarke concluded that the teacher who did not change simply did not have the space in her life at that time to make substantial changes to her practice. Nolder and Tytherleigh (1990) found that the impact of the LEA-based intervention, even

working with hand-picked participants, was tempered by pragmatic constraints in these teachers' schools. They report that for many schools "the change effected was not as radical as was initially envisaged and was to some extent a compromise" (p. 20).

The influence of teachers' pre-existing beliefs and attitudes on their propensity to change is highlighted by Cooney (2001) in a review of five studies (one UK, four USA) in which "teachers' conceptions about mathematics and mathematics teaching strongly influence, if not dictate, their movement towards a reform-oriented teaching environment". In the first of these studies, Wilson and Goldenberg (1998) identified a reluctance to change too radically even in teachers who were well disposed to reform. Grant, Hiebert and Wearne (1998) studied 12 primary teachers who attempted to reform their mathematics teaching and found that those who had a more 'pluralistic' view of mathematics were more likely to show improvement. Schifter (1998) reported a case study of two participants in a seminar for teachers in which big ideas in mathematics were examined. These teachers came to a better understanding of the problematic nature of students' mathematical thinking as they reflected on the problematic nature of their own mathematical learning. In the fourth study reviewed by Cooney, Jaworski (1998) identified a reflective and cyclical process of teacher research that involved teachers questioning and examining their own teaching and "through which teachers' knowledge grew and was refined" (p. 26). Finally, Frykholm (1999) tracked 63 secondary teachers on a professional development programme, concluding that beliefs alone did not necessarily translate into corresponding classroom practice even when the two were in direct conflict. This echoes one of the findings of Desforges and Cockburn (1987) - the possibility of a mismatch between teachers' articulated beliefs about learning and their classroom practice.

There is also evidence that teachers' *perceptions* of their own change do not always match with their classroom practice (e.g. Spillane, 1999). Millett (1996) identified the particular problems in mathematics where teachers collectively lacked the confidence to discuss issues in depth and to take risks in changing practice. Askew *et al*. (1997b) found schools improving the effectiveness of their numeracy teaching given the availability of expertise, committed leadership, a substantial investment of time over several years and a cross fertilisation of ideas. Spillane (1999) also suggests that collaborative professional networks are important for teachers to make sense of the ideas promoted by reformers. Spillane reports that, of the teachers who thought they had changed with respect to the implementation of the 'reform' standards, very few actually had changed. These findings were replicated with respect to the implementation of the National Curriculum in an evaluation carried out at King's College, London (Johnson and Millett, 1996). See also Cohen (1990).

The transient nature of the school community is another factor that can disrupt the process of change. Instability can rapidly beset a small primary school due to individual teacher priorities and interests at particular times or external factors. For

example, in one focus of the King's College Leverhulme Numeracy Research Programme (Adhami, 2000), eight of the original 18 teachers left their schools at the end of the first year of a two-year year professional development programme. Notwithstanding evidence that long-term CPD is effective in bringing about teacher change (Askew *et al*., 1997), such an approach is particularly vulnerable to teacher mobility. Some attrition in this project appeared to be associated with high mobility in teaching generally, and London schools in particular; some of it due to the NNS; and some of it was particular to the group of teachers who were the subjects of the study. Similar levels of mobility were reported in a study of two three-year professional development programmes in Manchester (McNamara, 2002).

Smith (2000) found that almost all teachers on a long-term professional development initiative disliked the long-term nature of the programme. Postlethwaite and Haggarty (1998) note that there is very little literature about teacher change where teachers have not volunteered to take part; we know much more about teachers who *want* to change. Much of this research is rather project specific, and is reviewed below.

We simply note here that research on the development of mathematics teacher *educators* is difficult to locate. Being a 'teacher' of mathematics teachers involves skills and understandings in addition to those required to teach mathematics *per se* (Prestage and Perks, 1999a, 2000). Moreover, supporting the professional development of experienced teachers calls on approaches and, perhaps, attitudes different from those required in the initial training of novice teachers. The *Journal of Mathematics Teacher Education* (JMTE) includes articles that start to document aspects of teacher educators' learning related to their engagement in programmes for teachers of mathematics (e.g., Heaton and Mickelson, 2002; Remillard and Geist, 2002). Research on how teacher educators learn their profession, and how models of teacher professional development might extend to teacher educator development, is almost non-existent. Fragments can be found in the work of Halai (1998); Krainer (1999); Zaslavsky and Leikin (1999); Jaworski (1999a, 2000a); Prestage and Perks (2001); Tzur (2001). The issues also differ for 'career' mathematics educators based in universities and those chosen for that role in the context of particular curriculum development initiatives. The National Numeracy Strategy, for example, has a 'training' model of teacher development in which practitioners (Numeracy Consultants) 'deliver' a packaged training programme for the Strategy. The primary expertise of many such consultants has been gained as a generalist schoolteacher; their actual knowledge of mathematics and mathematics education may be modest.

From Nuffield to Numeracy: Four Decades of CPD

Two major curriculum development projects in primary and secondary mathematics, Nuffield Primary Mathematics (1966-71) and SMP respectively, were both funded by charitable bodies. Each had its associated programme of teacher development to support curricular and pedagogical reforms. The first LEA teachers' centres, for example, were an outcome of the Nuffield project (Watson, 1976), meeting a need for locally-based venues to house resources and to host meetings of teachers. The project

took a principled decision to develop printed resources for teachers – the Nuffield Guides (e.g. Nuffield Foundation, 1967, 1973) – and not to produce textbooks for children. Following two HMI Reports (DES, 1978, 1979), the Cockcroft Report (DES, 1982) and an HMI discussion paper (DES, 1985), the government of the day gave unprecedented support for professional development in mathematics throughout the 1980s (Biggs, 1983; Pinner and Shuard, 1985; Pirie, 1987), with direct funding for higher education accredited programmes such as the Mathematical Association Diploma in Mathematical Education (Melrose, 1982, 1983). The 1980s also saw a number of government- funded CPD programmes linked to post-Cockcroft curriculum innovation projects. The Low Attainers in Mathematics Project (LAMP) (Ahmed, 1987) and its successor, the Raising Achievement in Mathematics Project (RAMP) (Ahmed and Williams, 1991), addressed investigative approaches to teaching secondary mathematics. In the primary phase, Primary Initiatives in Mathematics Education (PrIME) 1987-92 (Shuard *et al*., 1991; Rowland, 1988/1994) addressed a comprehensive range of Cockcroft implementation issues, notably the integrated use of hand-held technology – the Calculator-Aware Number Curriculum (CAN).

In response to the implementation needs of the first National Curriculum in 1989, 20-day courses were introduced by the DES in 1990 for primary mathematics (and science) teachers through the LEA Training Grant Scheme (LEATGS). The programme aimed to enhance subject knowledge, pedagogical and dissemination skills for the implementation of the new National Curriculum. 20-day course opportunities, which spanned most of the 1990s, have in turn given way to another government priority, the introduction of the NNS in 1999. The implementation of the Strategy, together with its associated cascade-training programme, has perhaps been the first example of synthesis of wholesale intervention and professional development in an unprecedented move towards a prescribed pedagogy for primary teachers, extended to lower secondary in 2001.

Running alongside these latter two government initiatives over the last decade a raft of modular masters, and other higher degrees, have become an established route for teachers voluntarily undertaking CPD. Many of these award-bearing courses have included ‘teacher research’ as one assessed element, typically towards the production of a dissertation of some kind. A more recent innovation is the plethora of government initiatives which, broadly speaking, go under the banner of teacher–as-researcher in ways not traditionally associated with award-bearing courses. They include the teacher research grants programme funded by the Teacher Training Agency (TTA); school-based research consortia funded by the TTA and the Centre for British Teachers (CfBT); the DfEE ‘training school’ initiative that claims research as one of its four main strands; and, most recently, the DfEE Best Practice Scholarships. Many of this latter group of initiatives are lodged within the rhetoric of evidence-based practice, a notion derived from a medical/nursing model of professional development.

A number of curriculum reform and professional development initiatives from the 1960s (Nuffield Primary Mathematics) to the present time (the NNS) have been directed at primary school teachers. As specialists in one or two subjects, yet typically required to teach across the whole curriculum, they face particular challenges with regard to professional development needs. Watson (1976) noted the willingness of primary teachers to learn and adopt new approaches. "Where their secondary colleagues have seemed at times unable or unwilling to recognise their need for updating, primary teachers have come forward willingly with enthusiasm and refreshing openness to new ideas" (p. 67).

This brief historical survey, and the sections that follow, review overtly mathematical CPD initiatives and opportunities. It is not clear to what extent it is useful to look at generic research on professional development to inform research and practice in mathematics teacher development specifically, as the knowledge base is extremely limited (e.g. Brown and Borko, 1992; Clarke, 1994; Darling-Hammond, 1998).

Models of Development in Mathematics Teaching

The Mathematical Association Diploma

The Mathematical Association entered the field of In-service qualifications for teachers in the late 1950s, in response to a report of the Association of Teachers in Colleges and Departments of Education (ATCDE) which found that only a quarter of mathematics teachers had a 'good honours' degree in Mathematics (Price, 1994). Although the first MA Diplomas concerned themselves entirely with improving mathematics subject matter knowledge, a new Diploma in Mathematical Education devised to meet the needs of teachers of children between the ages of 5 and 13 started in the late 1970s and ran throughout the 1980's as a two-year part time course at some 50 centres nationally. The course had four assessed components: mathematics, mathematical education, mathematical investigation and special 'Child Study' (Price, 1994). The 200 hours of tuition was initially available only in evenings, weekends and half-terms. By the mid 1980's Grants for Educational Support and Training (GEST) funding had became available for some day release. From 1985-90, the one-year Cambridge-based course, for example, enabled release from school for one day per week in the Autumn and Summer terms, and for five weeks full-time in the first half of the Spring term.

Most MA Diploma participants had responsibility for the subject in their schools, many being heads or deputies. An evaluation of the early years of the new Diploma (Melrose, 1982, 1983) reported that 60% of participants found both the mathematics and mathematics education components very or fairly helpful, compared with only 45% for the special study and 35% for the investigation component. 40% of students reported the course to be fairly effective, and 26% limited in its effect upon the organisation and leadership of their school. These rather depressing findings may reflect a radical initiative in its infancy; unfortunately there was no replication of the evaluation. By the end of the 1980s over 6000 teachers had embarked upon the

course. Many of them subsequently went into LEA advisory work. Arguably, the investment made in that period is now bankrupt, in the absence of any comparable opportunity for sustained CPD in primary mathematics.

The 1980s also saw the introduction of MA Low Attainers Diploma and a Diploma for Heads of Department, respectively attracting some 800 and 200 participants. Lack of funding for such substantial courses, coupled with the pressures arising from the introduction of the National Curriculum in 1989, led to the disappearance of the Diplomas early in the 1990s.

LAMP

One DES/LEA-funded post-Cockcroft curriculum development project, LAMP (1983-1986), was related to low attaining secondary pupils. Both LAMP and RAMP (see later) were based on the principle that " … improvements and change can only be sustained if teachers in the classroom believe in and support the developments taking place. Impositions from above are therefore unlikely to work". (Ahmed, 1987, pp. 81-2). 12 teacher researchers and a network of 200 teachers became involved, each being given some release from the classroom.

The aims of LAMP included encouraging teachers to change their attitudes to low attainers; using problem solving and investigatory mathematics; exploring informal approaches to assessment; changing students' perceptions of mathematics and enhancing their confidence and independence. The achievements of the project included enhanced pupil attainment, with increased numbers taking A level; teachers feeling greater satisfaction; greater collaboration and cohesion in departments; and teachers becoming more discerning about in-service provision and resources, enhanced involvement of parents. (Ahmed, 1987)

The project report includes recommendations for professional development in mathematics, including the need for classroom teachers to be more involved in their own professional development, and to be given sufficient time to pool experience and expertise with colleagues.

RAMP

LAMP led on to another three-year curriculum development project, jointly funded by the DES and 34 LEAs. RAMP (1986-1989) set out to demonstrate how pupils of all abilities and aptitudes were able to achieve better test and examination results, along with increased motivation, confidence and interest through 'using and applying mathematics'. 70 teacher researchers were released for one day per week and RAMP the in-service programme affected some 8000 teachers. The project report (Ahmed and Williams, 1991) concludes that teaching facts and skills in isolation from conceptual structures and general strategies can undermine pupils' confidence and competence. The report recommended that schools and LEAs should incorporate teacher development policies as an essential part of any curriculum planning; that long term research and development work in mathematics education should be

centrally co-ordinated and involve participation by practising teachers; and that a central body should be responsible for monitoring and quality control of the professional development of teachers.

As is often the case, one has to turn to an independent evaluation (Selinger, 1987) for a more critical perspective on RAMP and LAMP. In a generally sympathetic account, Selinger noted that teachers involved in these projects seemed to have changed their attitudes towards mathematics teaching, but questioned whether these teachers' classroom practices had actually changed. In a case study of two teacher-researchers, Selinger found that their beliefs and attitudes about mathematics teaching had changed, but that they had not sufficiently taken into account the reactions of their pupils. She also found that the teacher-researchers' attitudes about 'effective' INSET had changed; they believed that change takes time and requires the active involvement of participants. With reference to Selinger's research (*op. cit.*), Ruthven (1999) points out that the significant focus of both projects on reflective practice poses an epistemological problem: the developing shared understandings of an in-group of participating teachers gave rise to a tendency to discount the alternative perspectives of pupils and of teachers not directly involved in the projects.

PriME

The Cockcroft Report had pointed to the need for developmental work in mathematics teaching which would take into account the technological and social changes of the previous two decades, and draw on the resource of research and development which had become available. The PrIME project (Primary Initiatives in Mathematics Education) aimed "to help [primary] teachers to carry out the recommendations of the Cockcroft Report, taking account of the impact of the new technology" (SCDC, 1986, p. 1), with a comprehensive agenda including language in mathematical thought and learning, mathematical investigations and problem solving, the role of practical work, teaching styles, classroom organisation, gender, culture and the role of parents. PrIME is now best remembered for CAN (Calculator-Aware Number Curriculum), the component associated with developing the use of calculators.

CAN supported a number of primary schools in which each child had free access to a calculator, with integrated use of calculators in classroom mathematics activity. One study of the early stages of CAN in one LEA (Rowland, 1988/1994) noted that 6 to 7-year-old children exposed to a calculator-aware curriculum tended to develop early familiarity with large numbers and efficient methods for mental calculation with numbers less than 100. This study also noted that involvement in CAN had caused some teachers to raise their expectation of what young children can do and understand in school mathematics. Teachers acknowledged that participation in CAN had been a strong influence on the investigative patterns of teaching and learning which were developing in their classrooms. However, the same study reported that the least able children (in mainstream classes) seemed not to benefit from their access to calculators, and that procedural and apparatus-based approaches to teaching

mathematics were deeply ingrained. The CAN-appointed national evaluator concluded (Duffin, 1993) that the project had influenced the mathematics curriculum, supported the development of an investigative teaching style and empowered children. The PrIME project team's CAN report (Shuard *et al.*, 1991) is a vivid account of the experience of pupils and teachers involved in the project.

Twenty-day courses

These specially designated courses for primary mathematics (and science) teachers were established in 1990-91in a ten million pound DES programme funded through the LEA Training Grants Scheme (LEATGS). One of the requirements for LEATGS funding and course 'designation' (i.e. publication in an approved list) by the DES was LEA/HEI partnership, with teaching and assessment undertaken by one or the other, or jointly. At one extreme, the Open University produced materials (Mason *et al.*, 1990) intended to support courses wholly provided by LEA and school personnel.

The declared aim of 20-day programmes was to enhance the subject knowledge, pedagogical and dissemination skills of primary school teachers for the introduction of the National Curriculum. The first year of the planned three-year programme was evaluated by Harland and Kinder (1992) at NFER (see also DES, 1991a). This evaluation covered a number of course models, including those 'delivered' by the LEA alone. Patterns of attendance tended to be one day per week. Assessment of course participants was undertaken or overseen by the HEI, and many gave credit towards Advanced Diplomas (and even Masters degrees) for successful course completion.

The brief for the NFER evaluation reflected a new concern at the DES for 'effective' (in terms of the impact on whole-school practice), value-for money course provision by the partnerships. Related issues concerned (a) the extent to which HEI mathematics specialist personnel involved in INSET were sufficiently in touch with primary school pedagogy (b) desire for rigour in assessing learning outcomes for course participants (c) the concern of some LEAs to use LEATGS funding as one way to hold on to advisory staff in the face of growing devolution of central LEA budgets to schools. These factors underpinned a certain tension in partnerships: LEAs needed an HEI partner to attract the funding, but many were reluctant to buy their teaching and accreditation services (such as credits towards Diplomas).

The main findings to emerge from the evaluation included:

1. the opportunity to attend in school time and the quality of course tutoring made it a qualitative improvement on participants' previous experience of INSET;
2. participants reported greater confidence in their subject understanding and enhanced capacity to teach open-ended, practical and investigative activities;
3. 'interactive presentations' using short exposition and focused questioning within extended opportunities for experiential learning was seen by participants as a model of good practice for classroom teaching and dissemination;

4. the prime influence on teachers' capacity to disseminate was confidence in their knowledge and understanding of the subject and its processes. Consequently, the effectiveness of any generic dissemination training is questionable;
5. weak course-school links: the recruitment of advisory teachers as course tutors by HEIs was evident, but there was a low incidence of intended advisory teacher follow-up in schools;
6. little interest in the 'carrot' of HEI academic awards: only a minority of participants sought HEI accreditation and it was rarely a motivation to attend. The necessity to write and submit assignments as a condition of accreditation was a major disincentive;
7. there was little evidence of substantial impact on participants' schools during or immediately after course attendance. The report questions whether most primary schools can provide either the time or the *milieu* to ensure that benefits will extend significantly beyond the course participants.

In the middle-to-late 1990s, 20-day courses gave way to 10-day and even 5-day courses addressing restricted elements of the National Curriculum, and eventually to 3-day NNS training. There is clear evidence from Askew *et al.* (1997a) that distinctive professional advantages accrued to teachers who were able to participate in the more sustained, longer-term training course.

The National Numeracy Strategy

Following the National Numeracy Project (NNP, 1996-1999), the NNS was designed to enhance the management of the numeracy curriculum and the pedagogic practice of primary teachers in interpreting and delivering the Mathematics National Curriculum Programmes of Study. Initial indications are that NNP and NNS have been well received with positive impacts reported upon teacher attitudes and their practices. (OFSTED, 1998, 2000; McNamara and Corbin, 2001; Millett and Johnson, 2000). The central figure in the NNS training model is the subject co-ordinator who, after a 3-day training provided by the LEA numeracy team, is subsequently expected to 'cascade' a prescribed INSET programme to their colleagues in school. Additionally the co-ordinator was given time-release to work alongside colleagues in their classrooms, and to give 'demonstration' lessons.

An evaluation of the first year of the strategy (OFSTED , 2000) located weaknesses in teachers' subject knowledge, particularly "teaching of progression from mental to written methods; problem solving techniques; and fractions decimals and percentages" (p. 6). Their report also identified cascade training as a weak link in the strategy. Although it acknowledged that the distance learning materials provided enabled co-ordinators to start to help teachers learn the principles of the strategy it noted that:

> given that the existing weaknesses in the teaching of mathematics are largely concerned with teachers' subject knowledge, there is a strong case for extending the training programme, as a matter of urgency, to a great number of teachers. (*ibid*, p. 7)

In the 'whole school action on numeracy' focus of the King's College Leverhulme Research programme, reactions to LEA training and subsequent school-based INSET varied from positive to highly critical. Notwithstanding this, by the end of the year, consistently positive reactions to the *strategy* (not the training) were being expressed by co-ordinators and teachers in all schools (Millet and Johnson, 2000; Mcnamara and Corbin, 2001). Millet and Johnson conceptualise the "increasingly demanding" nature of the co-ordinator's role as incorporating such additional features as "agent of imposed change" and "monitor/evaluator of practice". Mathematics co-ordinators were indeed central to three of the six key constructs developed to characterise differences between schools in the implementation of the NNS: enthusiasm/lack of enthusiasm for the role of co-ordinator, clarity/obscurity of vision, and balance/imbalance between head teacher and co-ordinator. There was also a suggestion that a combination of circumstances, personal qualities, expertise, relationships and decision making in certain schools provided a stable foundation for taking change on board.

The first annual report from the external evaluators of the National Numeracy (and Literacy) Strategies also identifies the limitations of the cascade model to transform instructional capacity where both "content knowledge" and "classroom practices" are lacking. The evaluators identified that after the "modest but significant gains" in numeracy, further improvement would be dependent upon "teachers learning new skills" (Earl *et al*., 2000, p. 7) and observe that present improvement may be as a result of "motivation" and "concentration of existing capacities" (*ibid*, p. 36). However the evaluation generally maintains the optimistic view that the strategies (for virtually all the findings in the report are common to both strategies) represent "impressive reform levers that have considerable potential to establish an infrastructure for lasting change" (*ibid*, p. 4).

Evidence-based Practice

Davies defines Evidence-Based Education as "a set of principles and practices for enhancing educational policy and practice .. [that] operates on two levels. The first is to utilise existing evidence from worldwide research and literature… The second is to establish sound evidence" (Davies, 1999, pp. 108-9). Evidence Based Practice (EBP) is still in an emergent phase in education and this is signalled, in part, by the fluidity of the discourse: 'research-based' (TTA, 1996); 'research and evidence-based' (TTA, 1999); 'evidence-based' (Davies 1999);'evidence-informed' (Sebba, 1999). Initially promoted through initiatives such as the TTA teacher research grants scheme (1996-1999) and the Research Based School Consortia (1997- 2001); although similar it was ideologically distanced from the existing 'teacher-as –researcher' and 'classroom action-research' movements begun in the preceding decades (Elliott, 1991). Alongside *engagement in* research it privileged *engagement with* knowledge from the

wider research and evidence base to promote a 'what works', 'outcome oriented' model of educational research, a response, some suggest, to the 'crisis of legitimation' in educational research (Pirrie, 2001).

Ironically, current moves towards EBP in education are ideologically rather than empirically driven in that EBP itself is not as yet evidence-based. Initiatives such as those of the TTA, supported by Hargreaves' (1996a) TTA lecture, which sought to make teaching a research-based profession were based on extrapolations from other professional areas, such as medicine, where such professional practices were in the process of being implemented (Jacobson, Edwards, Grainier and Butler, 1997; Evidence-based Medicine Working Group, 1992). Such approaches remain controversial even in medicine, however, and their transferability to other professional areas such as teaching is contentious (Woolf, Diguiseppi, Atkins and Kameror 1996; Hargreaves, 1996a, 1996b, 1997; Hammersley, 1997; Foster, 1999; Elliott, 2001; Norris, 1996).

Some crucial issues underpin current debate. Interpretations of EBP range on a spectrum that, at one extreme, includes advocates who present it as an 'empowerment' strategy, as a formal and specialised knowledge base that would enhance professional autonomy and status. At the other extreme of the spectrum opponents expose it as an 'entrapment', a technology of teaching that denies craft knowledge and reduces capacity for professional action. There is also little consensus about what counts as evidence, inter or intra the major educational stakeholders (Baumfield and McGrane, 2000; Threlfall, 2000; Elliott, 2000) and in addition methodological debates are hotly contested (Evans, 2000; Elliiott, 2001; Hammersley, 2001; Oakley, 2001). Moreover, it remains unclear (a) for whom the evidence is intended e.g. policy makers, practitioners, parents, educational researchers etc.; (b) in what context is the evidence to be employed e.g. schools, individual teachers etc.; and (c) for what purpose is the evidence to be used e.g. to inform policy, to develop theory, to open new pedagogic possibilities etc.

It remains to be seen what model of EPB, if any, is applicable to education. Does the medical model fit? (Evans and Benefield, 2001) Without clear answers to such questions, the DfES has moved apace to provide an educational equivalent to the medical Cochrane Collaboration, which prepares, maintains and disseminates systematic reviews of effective health care interventions. The DfES 'Evidence for Policy and Practice Information and Co-ordinating Centre' is commissioning systematic reviews of school-based education research in order to build resource databases and help practitioners and policy makers to locate and access relevant research. See McNamara and Cobin (2001) and McNamara (2002) for extended accounts of these developments and debates.

The Japanese Model

A 'TIMSS Resource Kit' issued by the USA Department for Education (OERI, 1997) includes a videotape and case study of teaching and professional development in

Japan, significantly entitled 'Learning from Each Other'. We include a brief account of the Japanese approach here, in this otherwise UK-focused chapter, because it points to collegial attitudes to and modes of teaching development that will be explored more fully in the next chapter of this monograph. Whilst it is not clear how representative the video is of practice in Japan as a whole, it has attracted a good deal of interest as a model of CPD that affirms teachers' professionalism in an incremental drive to become better at what they do. Japanese teachers undergo a rigorous and intensive induction into the profession. A reduced teaching commitment allows for 60 days of closely mentored teaching together with a further 30 days at the local teachers' centre. Facilitated by a light teaching load compared with the USA and UK, the Japanese focus upon professional development continues systematically throughout a teacher's careers. After the 5th and 10th year of teaching, for example, teachers must attend resource centres for seminars, classroom observation and study (Jones, 1997). Throughout their careers, Japanese teachers engage in a continuous process of lesson development, meeting in 'lesson study groups' once a week for about an hour, to plan, implement and refine lessons collaboratively (Stigler and Hiebert, 1997, 1999) Teachers in Japan have an impressive level of professional competence and demonstrate high levels of mathematics subject knowledge (Whitburn, 1995, 1996). As a rule, schools encourage a high degree of interaction between teachers, and are characterised by a collegial approach to professional development (Japan Society of Mathematical Education, 2000). A similar climate of professional development seems to exist in China, where elementary teachers typically meet for one hour each week in 'teaching research groups' for 'intensive study of teaching materials' (Ma, 1999, pp. 136-7). Ma suggests that this is a significant factor in Chinese teachers' attainment of 'profound understanding of fundamental mathematics'.

Conclusion

Current government policies aimed at raising standards in primary schools have been experienced by many primary teachers in terms of imposition and initiative overload. CPD programmes can be seen as part of a perpetual readjustment in teaching styles, related to the evolution of learning theories and policy fashions (Brown, 1997). In the longer term, however, embedding policy has not always been understood in the terms in which it was presented (e.g. Millett, 1996), nor has it always been fully implemented before the next policy was devised. It would seem that funded evaluation of long-term CPD programmes has usefully, but sometimes exclusively, been directed at the initial stages of such initiatives (Melrose, 1982, 1983; Harling and Kinder, 1992), whereas it would seem reasonable to expect a degree of 'bedding in' so that a mid-term evaluation would be more indicative of the success of the programme. Nevertheless, a number of messages come across very clearly from the models outlined above.

First, the need to allocate sufficient quality time to CPD, and to involve teachers themselves in the management of their professional development. Askew *et al*.

(1997b) identified extended mathematics programmes such as 20-day courses as the most effective way of changing beliefs and practices so as to improve effectiveness in numeracy teaching. In reality, however, primary schools still retain an individualistic notion of development and one-day courses still predominate by virtue of time and cost constraints and perceived needs (Bottery and Wright, 1996).

Secondly, the cascade training so favoured by a number of these models is persistently identified as the 'weak link' in the process. Evaluation after evaluation carry similar messages to that relating to the 20-day courses: "It is questionable whether most primary schools, in particular, can provide either the time or the milieu to ensure such transmission. Evidence, however, suggests that a prime influence on teachers' capacity to disseminate is confidence in their knowledge and understanding of the subject and its processes. Hence the advisability of general dissemination training was questionable" (Harland and Kinder, 1992, p. 6).

Finally, deep 'whole school' change and dissemination of good practice must be firmly rooted in teacher experience and depend upon cellular growth of working groups - a 'diffusion' rather than 'dissemination' model, of which the Japanese lesson study groups might be one example. Many of the initiatives described in this chapter seemed to set out to *change teachers* rather than involving teachers in change. The external evaluation of the NNS (Earl *et al*. 2000, p. 10) concludes that good training and strong support from head teachers will not be sufficient for the further embedding of the strategy. "In addition, it will be essential to create strong professional learning communities at the school level".

In conclusion, we identify the following questions. Firstly, in what ways do the mathematics professional development needs of primary and secondary teachers differ? In what ways are they affected by differences in subject matter knowledge, curriculum, professional motivation and identity? Secondly, are the Japanese/Chinese practices of intensive examination of pedagogy within schools transferable to the UK context? If so, in what ways could they be facilitated and made most valuable?