

# DEVELOPING MATHEMATICS TEACHING AND TEACHERS

## A Research Monograph

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### CHAPTER 3:

## Initial Teacher Education for Teaching Mathematics

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# 3

## INITIAL TEACHER EDUCATION FOR TEACHING MATHEMATICS

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### **Introduction**

The apparatus of successive governments has increasingly shaped models of Initial Teacher Education in a way that has resulted in the emergence of a policy-driven, institutional process, now officially referred to as Initial Teacher Training (ITT). The current drive towards centralisation and political control was signalled in the early 1980s with the establishment of the Council for Accreditation of Teacher Education (CATE) in DES Circular 3/84 (DES, 1984) which sought to create a more practically based training, to limit the autonomy of training providers, and to shift the balance of power between Higher Education Institutions (HEIs) and schools by introducing partnership arrangements for the delivery and oversight of ITT courses (DES Circular 24/89, 1989a). Early indications of more far-reaching changes were signified by the establishment of alternative routes into teaching through the school-based Licensed and Articled teacher schemes (DES, 1989b) and the introduction of School-Centred Initial Teacher Training (SCITT) (DFE, 1993c).

MOTE (Modes of Teacher Education), the first national survey of training provision, showed that in 1991, 99% of the 45000 student teachers were still trained on programmes offered through HEIs: 31 universities, 36 Colleges of Higher Education and 22 Polytechnics trained 31%, 42% and 27% of pre-service teachers respectively (Barrett, Whitty, Furlong, Galvin and Barton, 1992). Indeed, in the decade since that first survey, the overall percentage of teachers trained through HEIs had not changed significantly (Furlong, Barton, Whiting and Whitty, 2000).

Indications of yet further drastic reform came in 1993 with the announcement of government proposals to establish the Teacher Training Agency (TTA) as a successor to CATE (DFE, 1993b). The role of the TTA was to include: funding; quality control/assurance; accreditation of training routes; teacher recruitment; and improving the quality of teachers and teaching. This remit progressively broadened to include Continuing Professional Development (CPD), Induction and National Professional Standards. It was not until after the Quinquennial Review of the TTA (DfEE, 1999c) that it slowly began to loose some of this portfolio.

Further attempts in the late 1990s to broaden provision by increasing the hitherto disappointing uptake of ‘alternative’ routes into teaching and extending the variety of ‘traditional’ training provision were arguably motivated by a desire to increase recruitment by providing prospective entrants a greater variety of access options, but also by determination to break the near-monopoly of the training providers. These included: the repackaging and relaunch of the Articled and Licensed teacher schemes as Graduate and Registered Teacher Programmes; the introduction of the ‘Training School’ initiative (2000); and the promotion of flexible (2000) and fast track (2001) routes. The situation became progressively more complex with the increasing variation of more ‘traditional’ provision: 4-year, and shortened 2-year, primary and secondary BEd undergraduate degree courses; 3-year BA/BSc undergraduate degrees (with Qualified Teacher Status); primary, secondary and Key Stage 2/3 [age 7-14] 1-year Post Graduate Certificate of Education (PGCE) courses; and 2-year PGCE part time and conversion courses. (The latter, mainly located in secondary training provision and in subjects such as mathematics, allow students with degrees in related subjects to train as teachers in a shortage subject area.)

The ‘effectiveness’ of these various routes is, as yet, unproven and indeed in most cases unresearched. Despite the cautionary note from Wilson *et al.* (2001), relating to the limitations of the USA research base on teacher preparation, the USA is still a good way ahead of the UK in this particular respect. Goldhaber and Brewer (2000), for example, report on a survey of 37000 12th graders in mathematics and 2500 in science taught by over 2000 mathematics and 1300 science teachers who held a variety of forms of teacher ‘certification’. Their results indicate that pupils taught by ‘standard’ certification teachers do significantly better than ‘private’ or ‘no’ certification teachers, but no better than those taught by ‘emergency’ certification teachers.

In comparison with the USA, the UK evidence base pales into insignificance, with only a few notable exceptions. Not only is the UK evidence base extremely fragmentary, relating often to single case studies or contexts, but also much of the literature and research into the domain is generic in content. It is possible to identify only a few studies and commentaries that are specifically mathematical in focus. Much of this subject-specific research relates to the mathematics subject knowledge of pre-service teachers, and has been reviewed in Chapter 2. It is also the case that, in the research literature we have identified relating to the initial education of primary teachers, it was uncommon to find aspects particular to mathematics education covered in isolation from issues relating to more general ‘professional’ studies, other than in the area of subject knowledge. In addition to the lack of research on ‘alternative’ routes there is also lack of comparative studies, other than inspection evidence, relating to the ‘effectiveness’ of the great variety of courses in the more ‘traditional’ routes into teaching, some of which have admittedly only recently been established.

## **Prescription and Regulation of ITT Provision**

As we have seen, over the last 20 years successive governments have progressively increased the control mechanisms and regulatory prescription relating to ITT, albeit at times with ideologically conflicting motives. The inexorable shift can be traced historically through official reports, surveys and policy directives (e.g. DES, 1983, 1984, 1989a, b; DfE, 1992, 1993a, b, c; DfEE, 1997, 1998a, b; HMI, 1982, 1983, 1987, 1988a, b, 1991a, b; and, OFSTED, 1992, 1993a, b, 1995a, b, 1998). Focused on the development and assessment of academic and professional competences, the utilitarian, practical and skills-based nature of the recent reforms reflects, not just a rethink of the theory/practice ratio, but a redefinition of ‘good’ practice in both teaching and ITT.

The most significant effect of the increase in prescription in relation to ITT has been the intensification of courses. Repeated demands to develop the partnership model of delivery and extend the school experience component of courses resulted in considerably greater pressure on the delivery of course components during university-based periods. Circular 24/89 required students on undergraduate primary and secondary ITT courses to spend 100 days in school and all other students 75 days; by 1991 this directive was met by all training providers and exceeded by some (Furlong *et al.*, 2000). Circulars 9/92 (DFE, 1992) and 14/93 (DFE, 1993a), however, increased the school-based component of PGCE courses still further to 120 days (secondary) and 90 days (primary). Undergraduate 4-year primary and secondary students were required to spend a minimum of 160 days in school.

Holyoake (1993), in a comparative review of European teacher education, noted that the UK was alone in attempting to erode both the length, and the university-based academic rigour of ITT. Others considered the new proposals ‘conservative’, ‘time constrained’ and lacking the flexibility, and the intellectual and professional foundation necessary to prepare teachers for the future (Bines, 1994; Dart and Drake, 1993). Carre and Ernest (1993) studying PGCE students as part of the Leverhulme Primary Project, found that the improvement in their knowledge of mathematics was not significant and expressed concern that an increasingly school-based training would cause it to deteriorate further. A second national survey of training provision ‘Changing Modes of Professionalism’ (1993-1996) revealed that all courses required to comply with the new regulations by September 1996 had done so, but even course leaders committed to a school-based model felt that the “maximum time in school had been reached”. Primary course leaders, in particular, seemed challenged by the new regulations and many were putting off compliance until absolutely necessary (Furlong *et al.*, 2000, p. 83).

The reduction in the time spent in non-practice-based activities throughout the 1990s was matched by an increase in the level and detail of prescribed learning. Circulars 9/92 and 14/93, for example, contained lists of competences that had to be achieved by pre-service teachers. The combined result of these two parallel modifications of

ITT courses was, not surprisingly, to render courses over-full, and to squeeze out previously key aspects of curricular and professional development.

The second major change for ITT providers in the mid 1990s was with regard to the assessment of the quality of training provision, now the responsibility of the newly established TTA. Training providers had previously been inspected by Her Majesty's Inspectors (HMI), but provision was made in the 1994 Education Act to extend the remit of the Office for Standards in Education (OFSTED), the body which inspected schools, to include inspection of all training providers. The inspections were of significant consequence to providers since 'non-compliance', or perceived failure to meet standards, could be penalised by a reduction in the allocation of training places.

Campbell and Husbands (2000), in a case study of two primary inspections (1996-97 and 1997-98) at Warwick University, contrasted the 'informed connoisseurship' model, formerly deployed by HMI, to the new 'technicist' model adopted by OFSTED. The move from HMI to OFSTED heralded an era of 'surveillance and control' that professed greater transparency of criteria, through the very public Framework for Assessment of Quality and Standards, and had the potential to lead to greater inter-inspector reliability of assessments and greater consistency of judgements across contexts. The criteria statements, of which the 1997-98 version contained about 160, were not, however, justified with reference to an external evidence-base, piloted or evaluated (Gilroy and Wilcox, 1997). Additionally, Campbell and Husbands claim that OFSTED did not expose to examination other documentation and procedures, such as the inspection moderation process and the exemplification of criteria in the training of new inspectors.

Standards of secondary mathematics ITT would appear, however, to have risen considerably since the early 1990s, judging by the official inspection evidence. HMI (1993) reported on a 1991-92 survey in which one third of university secondary PGCE courses were inspected and secondary mathematics was the only subject in which none of the work seen was better than satisfactory. Six years later, in inspections of secondary mathematics PGCE providers (1996-98), almost 75 percent were judged to be good or better. Analysis of the mathematics PGCE inspection reports, however, revealed considerable variation in how reports were structured and, in particular, in how criteria were applied and judgements expressed (Jones and Sinkinson, 2000). Sinkinson and Jones (2001, p. 221) argued that "attention to the transparency of the inspection process and to matters of validity and reliability is crucial if there is to be confidence in the inspection system". In fact, nearly 80% of ITT providers in a survey conducted by Graham and Nabb (1999) expressed a lack of confidence in the validity and reliability of the process.

A third major change in ITT provision was heralded by the publication of the National Curriculum for ITT (DfEE, 1998a), commonly referred to as Circular 4/98. [It should be noted that, from September 2002, the regulations set down in Circular 4/98 will be replaced by those contained in *Qualifying to Teach: Professional Standards for Qualified Teacher Status and Requirement for Initial Teacher Training*

(DfES, 2002) and exemplified in a handbook of non-statutory guidance.] Furlong *et al.*, (2000, p. 103) reported in their 1996 survey that course leaders were already finding curriculum planning an “increasingly technical affair” and one in which “more and more issues had to be packed into less and less time”. Financial pressures, as a result of the apportioning of student funding between HEI and school in respect of the latter’s greatly increased role, were also reported to have increased pressure on the delivery of the courses by increasing the casualisation of the workforce, threatening job security and increasing staff/student ratios.

### **The Standards Agenda**

One of the TTA’s first major projects was to devise a set of standards for the teaching profession. The National Standards for the Award of Qualified Teacher Status (QTS) (TTA, 1997b) was one of a portfolio of Professional Standards that included those for subject leaders, Special Educational Needs Coordinators (SENCOs) and Headteachers (TTA, 1998). Following in quick succession came the Career Entry Profile (1997) and the National Curriculum for ITT (DfEE Circular 4/98, 1998a) with a focus on subject knowledge and the requirement that providers audit primary pre-service teachers’ subject knowledge in Mathematics, English, Science and Information and Communications Technology (ICT). The combined weight of these assessment frameworks functioned as a quality assurance mechanism for newly qualified teachers. Ultimately also, the assessment of students through the OFSTED Framework for Assessment of Quality and Standards was a crucial mechanism for the regulation of ITT providers. The TTA aimed to generate ‘consistent and reliable’ assessment practices within and across training provision. In a survey of ITT providers, however, Mahony and Hextall (2000) found that the external assessment portfolio of QTS standards, Career Entry Profiles and Circular 4/98, when combined with locally negotiated practice, amounted to a ‘bureaucratic nightmare’. Although 63% of tutors felt course planning and assessment would improve as a result of QTS Standards only 8% felt that the overall quality of their courses had improved. It is arguable that rather than generating ‘consistent and reliable’ assessment practices inconsistent messages were again being conveyed in terms of the way in which different types of knowledge and assessment regimes were prioritised.

This tension was particularly apparent when, in addition to the audit of mathematics subject knowledge, a Numeracy Skills Test for all prospective teachers (primary and secondary) was introduced. The piloting of the ‘paper and pencil’ QTS Numeracy Skills Test, in 2000 was closely followed by the planned introduction of the computerised Numeracy, Literacy and ICT Tests in 2001 (the latter was abandoned in 2001 as a result of software problems). Two studies, Hextall, Mahony and Menter (2001) and McNamara, Roberts, Basit and Brown (2002), conducted in June 2000, reported pre-service teachers feeling extreme anxiety. They felt ‘insulted’ by the Numeracy Skills Test and a ‘deep sense of grievance’ that it had devalued existing mathematical qualifications, ‘shifted the goal posts’ to make them ‘jump through more hoops’, and, been designed to depict the government as a ‘gatekeeper of

standards'. Additionally, the test was not seen to relate to the broad range of mathematical knowledge they required in the classroom, or show understanding of their 'broader professional role'. The technical 'glitches' and organisational expertise involved in the later computerised tests (Hextall *et al.*, 2001) made them no less an administrative nightmare than the paper and pencil pilot.

Moreover, at a time when 'inclusion' and recruitment and retention of ethnic minority teachers is high on the government agenda, there is evidence to suggest that certain sections of the cohort may have been disadvantaged (Hextall *et al.*, 2001; TTA, 2000). The Numeracy Skills Test may also have other unintended consequences, in that it may cause students' conceptions of mathematics to become more 'hard-edged' and absolutist in conception. ITT has previously been reported to be successful in increasing students' confidence in their ability to teach mathematics and shift such absolutist beliefs (Bennett *et al.*, 1993; Carre and Ernest, 1993; Carter, Carré and Bennett, 1993; Brown *et al.*, 1999). Additionally, studies (Brown *et al.*, 1999; Green and Ollerton, 1999) have identified anxiety about mathematics as a major issue for pre-service primary teachers and the introduction of the 'test' may prove to jeopardise the success of some training courses in remediating the problem.

Over the last decade, however, the improvement reported by OFSTED in the standards of training providers would appear to be reflected in a rise in the standards of Newly Qualified Teachers (NQTs), according again to inspection evidence. In a 1992 survey (OFSTED, 1993) of 32 mathematics lessons taught by NQTs - 20% were graded 'unsatisfactory', 80% 'satisfactory' or 'good' and none 'very good' (quoted in Jones and Sinkinson, 2000). During the years 1997 to 2001 the percentage of 'unsatisfactory' or 'poor' NQTs in secondary schools has reduced by a third and the percentage of 'good' or 'very good' increased by 15%. Over the same period the percentage of 'unsatisfactory' or 'poor' NQTs teaching in primary schools has reduced by a half and the percentage of 'good' or 'very good' increased by around 20%. Recent figures appear to indicate that this upward trend has continued. Now, for the first time ever, over half of all NQTs observed by OFSTED inspectors during their induction year were rated as 'good' or 'very good' and only 5% of NQTs teaching in primary schools, and 8% in secondary schools, were rated by inspectors as 'unsatisfactory' or 'poor' (HMI, 2002, p. 92 quoted in Howson, 2002, p. 32).

## **Models of ITT**

### *Theoretical conceptualisations*

Aside from the official government model of ITT as a set of skills and competencies outlined in the sections above, a number of other theoretical conceptualisations have been suggested in the literature. These have included: 'apprenticeship of observation' (Lortie, 1975); development of expertise (Berliner, 1988); 'rite of passage' (White, 1989); 'legitimate peripheral participation' (Lave and Wenger, 1991); 'induction of novices by experts into culturally based understandings and skills' (Edwards, 1995); and 'cultural performance' (McNamara *et al.*, 2002). A

number of these models have been grounded in a social anthropological frame. Lave and Wenger's (1991) analytical perspective on induction, 'legitimate peripheral participation', for example, sees learning resulting from asymmetric co-participation within a community of practice where development of expertise and understanding is situationally and contextually grounded. Learning in this model is not 'from talk' but 'to talk'; the master/apprentice relation, where it exists, functions to confer legitimacy rather than to provide teaching. Whilst this perspective has gained currency in education, and mathematics education in particular, critics point out that learning in a school context "requires an understanding of the structure of pedagogy" (Adler, 1996, p. 9) and needs to take into account teaching, as well as learning, in the school as a 'community of practice'. One critique of the application of the 'apprenticeship' model to ITT claims that it reflects a false dichotomy between university and school-based elements, negates the importance of reflection and studies in educational theory, and does not correspond to the views of mentors (Jones, Reid and Bevins, 1997). Such observations are rooted in theoretical perspectives of the nature and growth of knowledge, addressed more explicitly in Chapter 5.

White (1989, p. 177) adopted the classic anthropological three-stage 'rite of passage' model to depict pre-service teachers' education. 'Separation' sees students 'cut the ties that bind them to the ordinary world' of college to embark upon the teaching semester where during their 'transition' into the 'real world' of the classroom they are inducted into the specialised body of knowledge and skills before finally being 'reincorporated' into college life, transformed by their experience. Exploring the applicability of this schema as a learning theory in relation to teacher education Eisenhart, Behm and Romagnano (1991) found it an inappropriate model, in certain ways, for the mathematics programme at one college. In particular, rather than creating experiences that were consistent and persuasive, a coherent ritual transmitted through a 'specialised body of knowledge', it was found that the programme endorsed inconsistent goals and created confused messages.

McNamara *et al.* (2002) present the experience of ITT as a complex matrix involving the student, the HEI, schools and government, in which transition is not linear but involves a back-and-forthness which repeatedly unsettles and repositions the 'initiant' in response to a complex, and often contradictory, set of agendas. Students depict their experience of embryonic teacherhood as 'game', 'play' and 'performance', interspersed by a series of 'ordeals' that legitimated their passage into QTS.

A picture of disparate, if not overtly conflicting, discourses and agendas, together with incompatible assessment practices, are reflected in some of these theoretical conceptualisations of ITT. This is indicative of fragmentation of, and lack of clarity about, the principles, practices and philosophies underpinning ITT; such outcomes are characteristically a potential hazard of current government-led HEI/school partnership model of ITT. Studies indicate that presenting pre-service teachers with

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competing demands could (McNally, Cope, Inglis and Stronach, 1994, p. 229) “create a role conflict in which they fail to achieve a sense of belonging and confirmation of teacher status”.

Brown, *et al.* (1999) in a study of primary BEd pre-service teachers depicted the training process predicated on supposing that such seemingly divergent demands could be reconciled and offered a theoretical framework for mathematics education comprising three dualities: phenomenological versus official accounts of mathematics; discovery versus transmission conceptions of teaching; and perceptual versus structural accounts of the training process. These pairs of potentially dichotomous perspectives might also be seen as complementary hermeneutic arcs (Ricoeur, 1981). The first of each pair reveals how pre-service teachers’ perceptions frame the space they are working in; the second shows how contextual parameters shape their perceptions. Analysis of data in the study, however, pointed to the pre-service teachers pursuing partial accounts of their transition with little attempt at overall reconciliation.

Empirical evidence relating to models of ITT is to be found in the 1991 MOTE survey of training providers, in which over 80% (218) of courses claimed to espouse a particular philosophy or model of professionalism. In over 70% of cases (across primary, secondary, undergraduate and postgraduate) this model was of the ‘reflective practitioner’. Only 6%, or 13 courses (mainly primary undergraduate), laid claim to a ‘competency model’. Other models reported in the findings were ‘theory into practice’, ‘teacher as researcher’, ‘problem solving’, ‘practical’, ‘teacher as manager’, ‘active learning’, ‘child-centred’ and ‘eclectic’ (Barrett *et al.*, 1992).

#### *The reflective practitioner*

Discourses of reflection (Adler, 1991) in the literature include content free ‘reflective teaching’ (Cruikshank, 1987), reflection on action leading to ‘reflection in action’ (Schön, 1983, 1987), and ‘reflection as critical inquiry’ (Zeichner and Liston, 1987). Reflective processes are often represented in three-level hierarchies (Van Manen, 1977; Carr and Kemmis, 1986; McIntyre, 1993), loosely derived from Habermas (1973), or in protocols such as “reaction, repair, review, research, retheorizing and reformulating” (Griffiths and Tann, 1992). Strategies claimed to foster reflection in pre-service teachers include action research (Carr and Kemmis, 1986; Liston and Zeichner, 1990), case studies (Ross, 1989), micro teaching (Sparks-Langer and Colton, 1991), theorising on the practice of others (McIntyre, 1993) and structured curriculum tasks (Smith, 1991). A number of educators also feel that reflective work provides a forum in which students can reconstruct their own identity as they become inducted into professional discourses (e.g. Hanley and Brown, 1996, 1999; Tann, 1993).

Despite its popularity amongst providers there have been various critiques of the use of ‘reflective practitioner’ techniques in ITT. Many studies indicate that that most students’ reflective thinking and writing remains seriously under-developed, and is

mostly of means/end descriptive character (level one), although Hatton and Smith (1995) found dialogic (level two) reflection occurred in one third of the essays of secondary BEd students based on 'critical friend' peer interviews. McNamara (1990) locates the real difficulty that pre-service teachers face as theorising classroom practice. The latter, it is thought by some, remains a much more productive exercise for experienced practitioners (McIntyre, 1993; McNally *et al.*, 1994). Edwards (1995, p. 600) identifies scant evidence in the literature to suggest that "reflection on practice in ITT is an opportunity to connect any sort of pedagogical theory with practice". Tickle (1994) in a study of 150 newly inducted teachers found that only 5% mentioned reflective practice as an important mechanism of support. Students often believed it a distraction from the serious business of learning teach (Zeichner and Liston, 1987), another 'hurdle' to get over (Bolin, 1990). Indeed, some feel that the skills required for reflection are very different from those required in teaching (McNamara, 1990). Outright health warnings for the use of reflection in ITT include potential damage caused by its capacity to expose personal deficiencies (McNamara, 1990), pose threats to classroom teachers (McLaughlin, 1994), produce anxiety, low self-esteem and disempowering self-doubt by emphasising the disparity between actual and intended classroom practice (Leat, 1995).

### **Partnership in ITT**

A fundamental change during the 1980s and early 90s was the considerable strides made by HEI and schools towards voluntarily developing 'partnerships'. Yet according to Brown *et al.* (1993), in a review of partnership and mentoring literature, 'partnership' is a problematic concept. Crozier, Menter and Pollard (1990), in a study of ITT partnerships, characterise it as a 'slippery and imprecise word'. Government, however, was soon to legislate on the nature of ITT partnerships (Circulars 9/92 and 16/93, DfE, 1992 and DfE, 1993a) and transfer, for example, responsibilities for practical training to schools. Edwards (1995) challenged the government's simplistic depiction (DfE, 1993a) of the student developing practical skills in the school and subject knowledge in the university. Furlong *et al.* (1996, p. 39) claim that HEIs subsequently went through a period when they "lost sight of" and had to redefine their "distinctive contribution" to ITT. Despite the now familiar 'rhetoric of partnership', Taylor (2000, p. 55) believes there is little acknowledgement in the literature of the additional 'cost'; or the relative distribution of 'resources', 'control', 'quality assurance', 'accountability' and 'penalties'. He nevertheless speculates that partnership offers the 'best hope for success': partnership, not a 'quick fix', is a "process not a outcome" in which the "specification of who does what is less important than the existence of shared values based as far as possible on a common knowledge base".

The 'Changing Modes of Professionalism' survey (1993-1996) identified a continuum of ITT-focused relationships that extended from HEI-led pre-1992 ITT courses to school-led SCITTS; although neither of the two extreme models could, they deemed, be considered partnerships (Furlong *et al.*, 2000).

SCITTs were the flagship of the government's plan to extend the variety of training provision, and in particular non-HEI provision. Six consortia of schools (three primary, three secondary) were established in the first instance, taking responsibility for course design, leadership and administration with little or no support from HEIs or other outside consultants. The primary SCITTs did, however, call upon LEA expertise to teach subject application (Furlong *et al.*, 2000). The inspection report (OFSTED, 1995a) of their first year of operation declared only one of the consortia "good" from the start and rated two "unsatisfactory". In a survey of primary headteachers, Hannan (1995) found little evidence of support for government proposals (DFE, 1993) to establish more independent school-based primary ITT (including the now infamous 'Mum's Army' scheme – a one year non-graduate scheme for early years teachers), although there was a desire to restructure the present arrangements to give primary schools a more significant role.

'Ideal typical' models of partnership were identified by Furlong *et al.* (2000, p. 78) as 'complementary' and 'collaborative'. The former, characterised by separate roles and responsibilities, was found to be most prevalent and was commonly seen to be a "pragmatic response to limited resources". In the latter model the partners were seen to have different, but equally legitimate, bodies of knowledge. The Oxford Internship Scheme (Benton, 1990), in its time a ground-breaking initiative, was posited as a classic example of this type of partnership. Other examples in the literature have been the Sussex Secondary PGCE partnership (Lacey, 1977; Furlong *et al.*, 1988) and, from a particular curriculum area, the Exeter history PGCE course (Nichol, 1993).

The Oxford Internship Scheme was a one-year secondary PGCE programme, launched in 1987, and developed on the premise of a very close school-HEI partnership that in many ways anticipated the legislation to follow. At any one time about 15 schools were involved with about 10 'interns' attached to each throughout two-thirds of the training year. The course had two components: a curriculum programme and a general programme. The former operated entirely on subject specialism and was the joint responsibility of a school-based subject mentor and a university-based curriculum tutor. Additionally, each school identified a professional tutor who, together with the university-based general tutor attached to the school, was jointly responsible for managing the general programme. McIntyre (1990a) identified six principles underpinning the scheme: (1) partnership – including joint planning of programme and roles between HEI and schools; (2) integration – involving a coherent programme, closely interconnected, allowing theory and practice to be tested against each other; (3) secure learning environments – carefully graduated to ensure students were not anxious or overwhelmed, given the centrality of classroom management issues in pedagogic decision-making; (4) diversity of sources – encouraged to inform student's thinking and teaching; (5) consensus not expected – between HEI and school about any aspects of good practice, divergence should be explored not ignored; (6) emphasis on testing – against a number of criteria, including theoretical coherence, consistency with research evidence and espoused

values, feasibility in relation to resources, expertise, effectiveness and acceptability (See also McIntyre, 1990b).

The 'Changing Modes of Professionalism' survey examined providers' perceptions of the 'location' of the principal course elements: subject studies (undergraduate); main subject application; core and other curriculum (primary) educational/professional studies and school experience. They concluded that, "despite the growing amount of time being spent in schools, there had not been any dramatic shift in the forms of training being undertaken there as opposed to what was offered within higher education" (Furlong *et al.*, 2000, p. 83). For example, elements seen by providers to still take place 'mainly' or 'wholly' in HEI were: subject application (by 30% of providers); educational/professional studies (by 40% of providers); and subject studies (by 85% of providers).

### **The Role of the Mentor**

A key feature of the new partnership arrangements has been the reconceptualisation of the role of teachers working with students from 'supervisor' to 'mentor'. In the first half of the 1990s the number of teachers formally designated mentors increased more than five-fold (Furlong *et al.*, 2000). Yet questioning the substantiveness of the evidence base about mentoring in ITT, Brown *et al.* (1993, p. 4) identify "little convincing evaluation of effectiveness as opposed to rhetorics of success".

A growing body of literature is now examining this dimension of school-based teacher education (e.g. McIntyre, Hagger and Wilkin, 1993) and positing theoretical models of 'good mentors' (e.g. Jones *et al.*, 1997) and 'influence' (e.g. Jones, 2001). Much of the ITT mentoring literature addresses professional and affective dimensions of the experience, however, and neglects the student as a subject specialist. *Mentoring in Mathematics Teaching* (Jaworski and Watson, 1994) is an exception in this respect as regards mathematics, with chapters that consider the special nature of mathematics (Sanders), the planning and preparation of mathematics teaching (Perks and Prestage) and the mathematics curriculum (French), amongst others.

The Mentor Development Project (Dart and Drake, 1993, p. 177) studied the induction of new secondary ITT mentors by experienced mentors finding that "Mathematics mentors talked a little of investigative mathematics teaching and its difficulties for trainees, but otherwise neither English nor mathematics mentors focused upon subject specific concerns". Brown *et al.* (1999) in a study of 20 primary undergraduate pre-service teachers also found little evidence that either class-teacher/mentor or university (school experience) tutor addressed issues relating to mathematics subject teaching when observing mathematics, focusing instead on classroom management and professional issues.

Smith (2001) focused on the influence of a mathematics teacher, who might also be a school-based mentor, on the improvement of students' teaching of secondary mathematics. The study reported on the nature of written guidance provided by mathematics teachers to a cohort of pre-service teachers of mathematics and

identified the influence of such guidance on them. The findings suggested that teachers advised pre-service teachers most frequently about classroom management, and other aspects of craft knowledge were shared within a framework of class management. Aspects of guidance were generally narrowly focused on traditional mathematics teaching craft skills of explanation, examples and exercises, with some attempt to exhort pre-service teachers to use a wide range of pupil activities.

Perhaps the most detailed account of mathematics mentor activity comes from Haggarty (1995) who, in a rigorously planned and trialled research and development project, studied the implementation of a one-year secondary mathematics PGCE programme at Reading University, modelled upon the Oxford Internship Scheme. The activities of six mathematics mentors in partnership schools were studied as they implemented a mentoring framework, which had been agreed in consultation with the schools. It involved arranging: observation of relevant phenomena and follow up discussions; participation in relevant activities; a teaching programme; discussion of planning; help with self evaluation; input of general perspectives on mathematics topics; and discussion of university tutors' comments. The mentoring process was felt to be the least successful aspect of the implementation of the PGCE programme as a whole. There was evidence that different mentors interpreted their various roles in different ways. One particular cause for concern, however, was that the mentors failed to capitalise on their principal strength, "their unique contextualized understanding of practice" (Haggarty, 1995, p. 104) through which the complexity of classroom reality could be explored. Instead, mentors appeared to model aspects of the tutor's role such as a focus on decontextualised theory. Observation of 'routine' or 'difficult' lessons was not encouraged; students were not observed as often as had been anticipated and often received no significant debriefing discussion. Haggarty surmises that mentors may have experienced difficulty articulating their own practice and that school culture may have precluded them from admitting and discussing their difficulties. A number of key factors were identified as significant in the effectiveness of mentors: views about teacher education, views about mathematics teaching, other responsibilities in the school, relationship with other teachers, and personality.

### **Beliefs and Attitudes of Pre-service Teachers**

Haggarty (1995) explored how Lacey's (1977) typology of pre-service teachers' strategies facing problems and displacing blame informed, and was informed by, her study. The strongly held opinions of a number of mentors with regard to mathematics teaching were, for example, identified as potentially counterproductive and contrasted with Lacey's analysis of pre-service teachers' behaviours as 'strategic redefinition', 'strategic compliance' or 'internalised adjustment'. 'Strategic compliance', indicated pre-service teachers' behaviour changes had been brought about under pressure whilst underlying beliefs remained unchanged; whereas 'internalised adjustment', indicated that changes had occurred in both pre-service teachers' behaviour and their beliefs.

Ernest (1989, p. 30) in discussing his model of mathematics teacher's knowledge, beliefs and attitudes identifies components as: 'beliefs' about the conception of the nature of mathematics, models of teaching and learning mathematics, together with principles of education; and 'attitudes' to mathematics and its teaching. He believes that "the crucial factor in developing beliefs and attitudes in teacher education is the form, rather than the content of the learning experiences". Miller and Baker (2001) explore a critical epistemology in which pre-service teachers' models of knowledge and beliefs about teaching and learning were explicitly challenged, and a language developed for describing, understanding and developing practices and positions. They developed, as an analytical tool, a two-dimensional matrix which charted primary student teachers' practices with respect to subject knowledge, beliefs and values, pedagogical positions and power relations, against their moral/social positioning as 'compliant'; 'reflective' and 'interrogative'.

Circular 4/98 specifies the content of training courses, and in particular the subject knowledge component, but it neglects to address the significance of pre-service teachers' beliefs about, and attitudes towards, the nature of mathematics and the processes involved in its teaching and learning. Yet there is a growing corpus of evidence to suggest that beliefs and attitudes can affect the way and extent to which curriculum reform is realised (Cooney, 1988). Andrews and Hatch (1999, p. 220), for example, in a survey of secondary teachers' conceptions of mathematics found evidence that "substantial numbers of serving teachers and many applicants for teacher training, may have perspectives on mathematics which counter the successful fulfilment of [current government] curricular expectations".

As noted earlier in Chapter 2, there is compelling evidence to suggest that experiences as a learner of mathematics, conceptions about the nature of mathematics and instructional practices as a teacher of mathematics are all profoundly interconnected (Thompson, 1984, 1992; Lerman, 1986, 1990; Meredith, 1993). The influences of 'pre-program beliefs' and 'culturally based filters' (Hollingsworth, 1988), employed as interpretive frameworks to make sense of classroom contexts, need to be made explicit and challenged if changes in behaviour are to be achieved (Ahmed, 1987; Bird, Anderson, Sullivan, and Swidler, 1993). The initial transition from school learner to school teacher, if it is to be successful, must often involve a considerable degree of 'unlearning' i.e. discarding of mathematical 'baggage', both in terms of subject misconceptions and attitude problems (Ball, 1988, 1990a, b). Lack of attention to this potential impediment is thought to "help to account for why teacher education is often such a weak intervention - why teachers, in spite of courses and workshops, are most likely to teach math just as they were taught" (Ball, 1988, p. 40).

Opinion is, however, divided as to how much ITT is able to substantively influence beliefs and attitudes. Some research indicates that frameworks are already fairly firmly fixed before training (Tabachnick and Zeichner, 1986; Zeichner, Tabachnick and Densmore, 1987). There is evidence to suggest, for example, that primary pre-service BEd students hold images of teaching formed from their own school days that

are highly influential in moulding their classroom practice (Calderhead and Robson, 1991). The beliefs and conceptions of mature entrants to teacher education programmes in mathematics have been found to be dependent on previous career experiences and to be resistant to change (Harel, 1994). Su (1992), in a study of 29 training establishments, found the teaching experience and the class teachers of greatest influence and the course curriculum less so. School pupils were ranked as most significant in helping pre-service teachers to judge their effectiveness as teachers and prior socialisation from former 'inspirational' schoolteachers, family and friends were important in helping them make the decision to enter teaching and remain in the profession. In a study of pre-service elementary teachers' beliefs, conceptions, and practices and their views of mathematical and pedagogical content knowledge, Foss and Kleinsasser (1996) found that their conceptions of mathematics remained constant during a mathematics methods course.

Bramald, Hardman and Leat (1995), however, argue that the effect of training courses do vary and belief systems are not as resistant to change as some research suggests. PGCE courses, for example, have been shown to have significant impact upon students in shifting beliefs about mathematics from absolutism towards relativism (Bennett *et al.*, 1993; Carré and Ernest, 1993; Carter *et al.*, 1993). Brown *et al.* (1999) found pre-service teachers' experiences, beliefs and attitudes as pupils at school often informed, in a negative sense, their ideal model of teaching in that they adopted 'child-centred' models of teaching. This was, in a number of cases, later modified by the intrusion of pragmatic classroom concerns, so that 'transmission' teaching, so often reviled by them as learner of mathematics at school, became their chosen model of delivery. Cheng (1990) also found humanistic views of teaching and learning, developed in college sessions, tempered by realism after teaching practice experiences.

## **Conclusion**

As we have seen, Initial Teacher Education has been framed by a number of, at times contrary, structural pressures over the last two decades. First, the proliferation of 'alternative' training routes, added to the increasing variety of more 'traditional' provision and providers, has caused fragmentation and lack of clarity about the principles, practices and philosophies underpinning ITT as a whole. We have little or no understanding of the philosophies that underpin the new 'flexible' routes or 'training schools', or the models of professionalism that are inherent in them. We have little idea of the particular costs and benefits that they pose for mathematics education or mathematics educators; or indeed, of their differential 'effectiveness' in the preparation of groups of pre-service teachers with diverse needs and expectations. Much of the comparative data relating to training provision is from sources such as OFSTED; little independent work of any magnitude has been conducted since the ESRC funded 'Modes of Teacher Education' (1991-1992) and 'Changing Modes of Professionalism' (1993-1996) projects. In-depth reports of practice are typically case studies of particular contexts or comparative studies across two contexts.

The second structural change has been an increased tightening of prescription for the regulation and assessment of training provision. The plethora of government directives relating to all aspects of ITT may have resulted in a stronger collective sense of the task, but only at the expense of diminishing notions of professional autonomy. This has resulted in some university tutors feeling they need to defend their own professionalism, defined in terms of broader educational aspirations, against a framework that to some seems rather narrow. Student teachers have also come under pressure to develop their practice according to government-led agendas, which can result in students specifying their own needs in somewhat restrictive terms, in line with government requirements. Can student teachers develop a capacity for working on their own professional development in a way that relates to their personal aspirations of what it is to be a teacher? How can we as educators model such activity as we balance the competing demands of individual professional autonomy and collective state and student entitlement?

Finally, with regard to partnership, there has been an ideological and practical shift in the context of ITT and the dynamics of the power balance between government, HEI, school and student. There is now a substantial literature on partnership in ITT but, again, much is based on the experience of one provider rather than coming from wide ranging studies. We are as yet unable to answer questions such as those posed by Wilson *et al.* (2001) on the content of pedagogical preparation, instructional methods and contexts best suited for particular aspects of teacher preparation; on the relative contributions of college sessions, assignments, teaching experience, to pre-service teachers' progress in learning to teach; or on the importance of their particular school experience context on the outcome of their practice. Indeed, there seems to be little consensus on even whether consistency across contexts is important. Whilst many studies identify the hazards of conflicting practices and philosophies between HEI and school-based school course components, the Oxford Internship scheme did not expect consensus, and divergence was explicitly 'explored not ignored'. Finally, there has been a plethora of literature on mentoring, a crucial component of partnership models, but we are still unclear about how to develop 'effective' subject mentoring in secondary partnerships. The situation in primary partnerships with regard to subject mentoring is even more challenging and less well-documented.