THE SUPPLY OF SECONDARY SCHOOL MATHEMATICS TEACHERS

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This paper provides evidence of a long-standing shortfall in the supply of fully qualified mathematics teachers in English secondary schools and suggests that the situation is deteriorating. The selection of applicants for courses leading to Qualified Teacher Status (QTS) is discussed with particular reference to one secondary mathematics PGCE course. Rates of achievement of QTS among those accepted for initial teacher education (ITE) in secondary mathematics are examined in the light of small scale qualitative research among the same groups of PGCE students. The concluding discussion highlights issues for consideration by mathematics educators.

THE SHORTFALL

As recently as the late 1980s around 5% of all first degrees awarded in England were in mathematical sciences (University Grants Committee, 1987) but the same figure for the late 1990s remained consistently below 2% (Higher Education Statistical Agency, 1995-1998). Table 1 compares the total numbers of mathematics graduates with those who proceeded to ITE courses between 1995 and 1998. Since 1996 the DfEE has published target numbers for mathematics ITE, based on a model for teacher supply (DfEE 1998), and those figures are also given in Table 1.

TABLE 1: Numbers graduating in mathematical sciences after full or part-time study in England and Wales, and as a percentage of graduates in all subjects. Numbers proceeding to PGCE courses as compared with the ITE target figures.

Year	No. of maths grads	% maths grads of total grads	No. of maths grads into ITE	DfEE target for maths ITE
1995	3540	1.8	514	unknown
1996	3537	1.8	421	2700
1997	3296	1.6	398	2370
1998	3717	1.8	308	2270

The revised DfEE targets for maths ITE in 1999 and 2000 are 2230 and 2180 respectively and the liklihood of meeting those will partly depend on the numbers on undergraduate courses at the present time - a number that is also falling. Neither mathematics nor the teaching of mathematics is a popular career option for young people in England and Wales. This was convincingly argued in 'Tackling the Mathematics Problem', an influential report published jointly by three national mathematical organisations.

Many countries are concerned about recruitment to science and mathematics undergraduate courses. However, it would appear that the important aim of sending mathematically competent students to university to study quantitative subjects is being more satisfactorily met elsewhere than in the UK.' (London Mathematical Society, Institute of Mathematics and its Applications, Royal Statistical Society, 1995).

Wolf (1996) argues that differentiated provision in years 10 and 11, accompanied by tiered GCSE examinations, is reducing the facility of 16 year-olds to continue with mathematics. Since it became possible, from 1992, to obtain a B-grade from the intermediate papers there has been a significant drop in the numbers entered at the higher level. This makes it difficult for such students to progress to A-level since their mathematical knowledge is inadequate. Most young people, including many who go on to become teachers, have no mathematics beyond that required for an intermediate GCSE. Of those who do continue with mathematics few, and a decreasing number, wish to enter teaching. Between 1995 and 1999 the numbers of mathematics graduates entering ITE fell by 40%. Increasing the quantity of secondary mathematics teachers will largely depend on reversing these trends. During the 1999/00 academic year all those entering mathematics or science ITE have been awarded £5000, half during the year and half during the following year provided they are in a teaching post. Vacancies in schools are another indication of supply problems. Although almost certainly an underestimate, the DfEE recorded 141 unfilled mathematics posts in 1998. The scale of this underprovision can be ascertained by estimating the numbers of pupils in that year who would have been affected by those vacancies - in excess of 20000, based on 5 classes with 30 pupils per class. This number is over and above those children whose mathematics teachers were less than fully qualified.

Since the 1950s there have been Government figures for the numbers of qualified mathematics teachers in secondary schools but their interpretation requires an understanding of the changing definitions of 'qualified' and of changes in the structure of schooling over the past half century. For example when the school leaving age was raised to 16 in 1972 there were approximately 8000 teachers with mathematically based degrees in secondary schools in England and Wales (DES 1974). We have no way of knowing what proportion of their time was spent teaching mathematics but we do know (DfEE 1998) that there were over 3 million secondary pupils in England in that year. Assuming that the mathematics graduates were also professionally trained, that they spent their full timetable teaching mathematics and estimating for the number who taught in Wales, then we have a ratio of one qualified mathematics teacher for roughly 400 pupils. One quarter century later, in 1997, approximately 12000 secondary school teachers in England and Wales had a mathematically based degree (DfEE 1998) and the number of secondary school pupils in England was still just over 3 million (DfEE 1998),

giving the equivalent ratio of 1: 250. This indicates serious under-provision and accounts for the employment of unqualified mathematics teachers.

The highest levels of formal mathematics qualifications of teachers of mathematics are published annually by the DfEE in 'Statistics of Education: Teachers'. In 1996/97 for example, 40% of those teaching 11-18 year-olds had a degree in mathematics (pure, applied or statistics), a further 40% were qualified in mathematics beyond GCSE level predominantly through B.Ed. degrees, PGCE certificates and Certificates in Education (no longer awarded) in which mathematics would have been a main subject.. The remaining 20% are recorded as having 'no qualification' in mathematics and, although qualified to teach another subject, they may or may not have had an A-level in mathematics. Other data in the same publication (DfEE 1998) reveal that this group provided 9% of the tuition in mathematics, reflecting their commitments elsewhere in school. They were more likely to be teaching younger pupils (11% of tuition in years 7-9, 8% in years 10-11 and 3% in years 12-13). The aims of the revised national curriculum reiterate the entitlement of all children to a broad and coherent mathematical education and one which builds a 'secure framework of mathematical reasoning' (QCA, 1999). Its successful implementation is clearly dependent on an increased supply of high quality mathematics teachers.

PROFILES OF TWO SECONDARY MATHEMATICS PGCE COHORTS

As a case study I will describe some of the ways in which the mathematics PGCE course at London University's Institute of Education is developing in response to those background factors. We recruited below target for 1998/99 but 84% of those who registered gained QTS and 89% of those are now in teaching posts, all but one in the Greater London area. Our target number was reduced for 1999/00 partly as a result of the increase in two forms of in-school training and partly as a result of our 1996/97 OFSTED inspection. We reached our recruitment target for the current year (99/00) without difficulty. Here are some details of the two cohorts:

TABLE 2: Profile of mathematics PGCE students at the IoE, London, 1998/99 and 1999/00

Year	Class of degree *	% with maths in title	% with sec ed. outside UK	% with non-UK degree	Ages at start of course	% gaining QTS	% in posts one term later
1998/99	1 1				20-24 16		
n=43	2.1 9				25-29 12		
(F:20,	2.2 19	70	23	16	30-34 9	84	89
M:23)	3 5				35-39 5		
	Pass 9				40-44 1		

1999/00	1	8				20-24	18		
n=42	2.1	14				25-29	9		
(F:18,	2.2	12	62	29	10	30-34	3	n.a.	n.a.
M:24)	3	4				35-39	5		
	Pass	3				40-44	3		
	M.Sc.	1				45-49	0		
						50-54	4		

*This is the degree which qualified the applicant for a place on the course. In some cases the applicant also has a higher degree.

We select for interview those applicants who appear to have a minimum of 50% mathematical content at degree level, whether or not 'mathematics' appears in the title of the degree. A significant number have degrees in engineering and many have degrees combining mathematics with other subjects. We probe mathematical knowledge at interview by means of asking candidates to prepare to talk about a particular mathematical topic and, for 2000/01, ask applicants to submit written solutions to selected questions.

We also expect candidates to spend some time in a secondary school prior to interview. This is particularly important for those without recent experience of non-selective UK schools. The mean age and range of ages in each of the two cohorts indicates that many of our students bring considerable non-teaching work experience into the profession but they may not be familiar with contemporary London schools. Although the majority of our ethnic minority students are British and were educated here we recruit a significant minority from outside the UK. Difficulties can arise about different expectations of schooling among older students and among those educated within different systems.

EXPECTATIONS AND PERCEPTIONS OF THE PGCE COURSE

By means of pre and post-course questionnaires completed by our 1998/99 cohort, and to be refined and repeated in subsequent years, I am building up a picture of the difficulties encountered during the course and uncovering some contradictions between expectations and perceptions. On the pre-course questionnaire the students were asked to indicate which difficulties they anticipated and where they expected to obtain support. The areas of possible difficulty reflected feedback obtained during course evaluations in previous years. I analysed the responses in terms of the unanticipated difficulties encountered on the course and on the additional difficulties reported. I also looked at the students' perceptions of available support by enquiring where support was sought.

The area of greatest unanticipated difficulty was in the management of pupil behaviour. It was experienced but had not been anticipated by 33% of female and

70% of male respondents. Such gender related differences between expectations and perceptions of difficulties extended to lesson planning, time keeping, managing workloads, subject knowledge, professional development and personal finance. The only unexpected difficulty experienced predominantly by women was with voice development. The sample was small because only 22 students identified themselves on both questionnaires but the exercise will serve as a pilot study for future course development and evaluation. It is this year-on-year refinement of the course which is enabling more students to complete it successfully. Our judgement during the selection process is more reliable and we are increasingly able to target support for those on the course. Our evaluations also inform the developmental work we do with school mentors.

CONCLUSIONS

The acute shortage of qualified mathematics teachers is likely to continue until more young people study mathematics beyond the intermediate level GCSE. There is evidence from other countries that, where mathematics is a compulsory component of post-16 education, more students go on to mathematically based higher education (Wolf and Steadman, 1998). Kitchen (1999) has evidence that many pupils who have high GCSE grades do not choose to take mathematics at A-level and that this is especially true of girls. Moreover she reports that less than half of those who take a double A-level in mathematics go on to a mathematics degree. It will be necessary to evaluate the effects of the coming changes at Key Stage 4 from the standpoint of post-compulsory participation in mathematics. Significantly, will the take-up of AS level mathematics increase under the new sixth form curriculum? If so, will the additional year of study enable students, male and female, to appreciate what Dolton and Vignoles (1999) describe as the 'mathematics premium'? Not all groups in society are equally likely to study post-compulsory mathematics. Woodrow (1996) discusses observed ethnically related differentiated choices and points to the existence of a 'group academic identity' in terms of subject preferences and interests. He suggests that further study of such factors has the potential to reveal strategies for attracting more young people into careers in mathematics and science. Whether or not those careers will include, for many more than at present, the teaching of mathematics will depend on how successful Government moves to increase the rewards for teaching turn out to be. It is essential that changed structures and conditions within the profession are evaluated.

I have provided evidence of successful acquisition of QTS by mathematics graduates and by graduates in several categories outside the small group who have recent single or combined degrees in mathematics from a UK university. There may be a need for additional and targetted support but it is a worthwhile investment when the outcome is a well-rounded mathematics teacher.

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