PROFILE OF THE MATHEMATICS TEACHING WORKFORCE IN THE COLLEGE SECTOR IN ENGLAND

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TERMINOLOGY

The term 'teacher' is used throughout this report to encompass lecturer, tutor, trainer and teacher.

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1 Profile of the science, engineering and technology teaching workforce in the college sector in England
2 Profile of the mathematics teaching workforce in the college sector in England
3 The maths teaching workforce across the post-16 education sector

DISCLAIMER

EXECUTIVE SUMMARY

INTRODUCTION

Developing the mathematical skills of young people remains a policy priority in England. As a condition of funding, from 2015 all students aged 16-18 without a GCSE grade A*-C must continue to study mathematics post-16. However, recent work[1] has demonstrated weaknesses in the teaching of mathematics and numeracy within the further education (FE) and skills sector, which could represent serious challenges to the successful implementation of such policies.

This report seeks to assess existing capacity in the system to address this issue, by providing detailed, robust and comprehensive evidence as to the academic and teaching qualifications of the mathematics workforce in both FE and sixth-form colleges (SFCs) across England. It also investigates this group of teachers' CPD experiences and professional development needs.

While acknowledging ongoing work to improve the quality of existing workforce data for the FE and skills sector, it was necessary to generate two new data sets for this report:

- An overview survey of colleges (40 SFCs and 65 general FE colleges) to determine the size of the mathematics and numeracy teaching workforce. In each college senior managers were asked to provide information about the number of staff teaching mathematics and numeracy and their mode of employment (full-time or part-time).
- A face-to-face survey with teachers from a random sample of colleges stratified by size and region. Interviews were undertaken with individuals who taught mathematics or numeracy and were available and willing to be interviewed at the time of this visit.
- An online survey of both FE and sixth-form college mathematics teachers to supplement the face-to-face survey was also conducted. In total 186 individuals who taught mathematics or numeracy as their primary teaching activity provided responses, either face-to-face or via the online survey (54% from FE colleges and 46% from SFCs).

KEY FINDINGS

- The mathematics workforce in English FE colleges is estimated to comprise approximately 830 full-time and 720 part-time mathematics teachers, and 920 full-time and 850 part-time numeracy teachers.
- The corresponding national figures for SFCs are 820 mathematics and numeracy teachers, 550 working full-time and 270 part-time.
- In full-time equivalent terms, the national FE mathematics and numeracy teaching workforce is therefore approximately four times that in SFCs. In FE colleges these staff are split almost 50:50 between mathematics and numeracy teachers. In SFCs the bulk of teaching is for GCE A-level Mathematics and Further Mathematics courses.

1 www.oftsed.gov.uk/resources/ofsted-annual-report-201213-further-education-and-skills

- The median age of teachers in SFCs is lower than it is in FE colleges (40 vs 48 years), and it is clear that the age distribution in FE colleges is typically older – hence simply meeting the replacement demand for mathematics and numeracy teachers in FE colleges over the next ten years is likely to be a challenge.
- 88% of FE college staff had teaching qualifications that would confer qualified teacher status compared with 94% of those in the SFCs.
- In terms of subject qualifications, all mathematics staff teaching in SFCs hold an undergraduate degree or higher, whereas staff teaching mathematics in FE colleges have a much wider range of academic or vocational qualifications.
- 82% of mathematics teachers in FE colleges hold at least an undergraduate degree. However, those working in SFCs are significantly more likely to hold a mathematics degree.
- 56% of staff teaching on the foundation numeracy and functional skills programmes hold a degree-level qualification or higher. However, almost 30% hold no qualifications above Level 4.
- Over half of FE college staff who hold a degree and teach numeracy and functional skills programmes do so with Arts, Humanities or Social Science degrees.
- Of those teaching GCSE and numeracy/functional skills without a mathematics degree, 43% do not have an A-level or equivalent in mathematics. Their highest mathematics qualification is generally GCSE Grade A*-C (or the equivalent), which is held by 96% of this group.
- Based on odds ratios, teachers in SFCs are 25 times more likely than their FE colleagues to teach A-level mathematics, whereas FE teachers are six times more likely to be teaching GCSE, and 46 times more likely to be teaching numeracy/functional skills than their SFC colleagues.
- The average number of years' teaching experience in both FE colleges and SFCs is approximately 15 years. However, FE teachers tend to join the profession later (median starting age of 32 years compared with 24 years in SFCs).
- FE college mathematics teachers are significantly more likely to have had relevant industrial experience (59%) compared with their SFC counterparts (39%).
- Teachers are significantly more likely to receive CPD on a regular basis if they work in a SFC as opposed to a FE college. For those receiving regular CPD, the most common pattern is monthly or termly (71% in FE colleges and 64% in SFCs).
- The most common forms of CPD being undertaken by both full- and part-time teachers were updates regarding qualification changes, followed by subject learning. Further details of teachers' reported CPD requirements can be found in the main text of this report.

CONCLUSION

1. The current FE workforce data, provided by the Staff Individualised Record (SIR), are not fit for purpose. The data are insufficiently granular to provide policy-makers with an evidence base on which they can anticipate and implement necessary interventions to ensure a future post-16 mathematics teaching workforce. As a minimum, data for mathematics and science teachers should be recorded independently, and teachers' qualifications included in data collection. Ideally the SIR would be mandatory for all institutions in receipt of public funding for post-16 education and training.

2. SFCs focus on teaching GCE A-level mathematics using full-time staff with degrees in mathematics. In FE colleges, teaching takes place across a more diverse array of mathematics and numeracy programmes. There is very little spare capacity in the FE workforce to take on the extra teaching that is required to deliver a more universal mathematics provision up to the age of 19. Possible ways to increase this capacity might include increasing the recruitment of mathematics, engineering or physical science graduates who choose to enter teaching to the FE and skills sector. However, this seems unlikely to be successful in the medium term given the wider labour market demand for such individuals, and the wage premium they attract outside of teaching. Perhaps more could be done to attract such graduates later in their careers into teaching.

3. To meet the expanded demand for post-16 mathematics teaching, it is likely that greater emphasis will have to be placed upon using the part-time workforce to teach up to GCSE level mathematics. However, this group does not typically hold degrees in mathematics (or a related discipline), and often have mathematics qualifications no higher than GCSE Grade A*-C. Enhancing their mathematical knowledge clearly requires considerable sustained investment in upskilling the current workforce.

4. More could be learnt about the challenges of implementing post-16 mathematics policy through a detailed examination of how mathematics is contextualised across the wider curriculum alongside students' discrete mathematics learning, and the support and training required for teachers to further enable this.

SECTION 1 INTRODUCTION

This report forms part of a larger project, commissioned by the Gatsby Charitable Foundation and Nuffield Foundation, to profile the background and experience of the English Further Education (FE) Science, Technology, Engineering and Mathematics workforce. This report focuses on the following areas:

- The challenge for the FE sector[2] to provide 16-19 learning programmes for learners who have not attained a GCSE A*-C mathematics qualification by the end of Key Stage 4;
- The resulting expansion in demand for mathematics and numeracy teachers;
- The demographic characteristics, qualifications and experience of the current FE sector mathematics teacher workforce in England;
- The particular challenges faced by FE colleges;
- Mathematics and numeracy teachers' CPD experience and requirements to meet the challenges they currently face.

For the purposes of this report the FE sector is divided into two components: the 224 general Further Education (FE) colleges, and the 94 sixth-form colleges in England. Mathematics provision for work-based routes outside of FE and sixth-form colleges is not considered here.

There are existing analyses that provide some information about the current mathematics teaching force in the FE sector. The Staff Individualised Record (SIR) provides information about the teaching workforce across FE sector colleges, but is limited by its non-compulsory nature and the continuing decline in response rates (about one-third of colleges in 2012/13). The Education and Training Foundation (ETF) published the most recent report, based on the 2012-13 SIR, in September 2014[3].

Their analysis is a useful source of benchmark data, and can be used to assess the representativeness of the sample used for this report, while also providing triangulation of results. However, within the SIR subject areas are aggregated in such a way that mathematics and numeracy lecturers and teachers (from now on teachers) cannot be identified as a distinct group (mathematics teachers are grouped with science teachers for example), information about qualifications of teachers is not collected, and individual level data are not available, preventing linkage of demographic variables to areas taught, and other variables of interest.

A second source of data specifically about English and mathematics teachers in the college workforce is provided by the ETF's (2014) report, *The qualifications of English and mathematics teachers*[4]. This is based upon two surveys, one of teachers involved in the GCSE Maths Training Needs Analysis (n = 246 of which 157 were from FE colleges) and the other, the Strategic Consultation Survey, of mathematics and English teachers in the college sector (n = 149).

However, due to the nature of the sample, the demographic information is somewhat limited and may not be representative of the sector as a whole. Nonetheless, the ETF report based on these surveys gives further useful information, and this provides opportunities to triangulate analyses of new data generated for this report.

2 The FE sector encompasses a variety of colleges and private training providers.
3 www.et-foundation.co.uk/wp-content/uploads/2014/09/SIR-Report.pdf
4 www.et-foundation.co.uk/wp-content/uploads/2014/09/RPT-Survey-v4.pdf

SECTION 2 METHODOLOGY

To provide the new data needed for this report, two surveys[5] were undertaken.

1 An overview survey of colleges to determine size of workforce for maths and numeracy.

This involved a survey of 40 out of the 94 English sixth-form colleges (43%) and 65 out of 224 English Further Education colleges (29%) representative of college size and region[6]. In each college senior managers were asked to provide information about the number of staff teaching mathematics and numeracy, and their mode of employment (full-time and part-time).

2 Face-to-face survey with teachers[7], employing a random sample of Further Education colleges stratified by size and region[8]. Each college selected was visited by a researcher who undertook face-to-face interviews with individuals who taught mathematics or numeracy, and were available and willing to be interviewed at the time of this visit. Thus the sample within colleges is an opportunity sample and is therefore likely to have some degree of bias. The representativeness of the sample is discussed in Appendix 2. Where colleges replied that they did not want to be visited, a replacement college in the same region of the same size was chosen at random. Hence, while not completely stratified by region and size, we have taken steps to ensure representativeness by these factors.

In addition, an e-survey was undertaken of both FE and sixth-form college mathematics teachers to supplement the face-to-face survey. In the analysis and the presentation of findings, the data from the face-to-face interviews and the e-survey are combined. In total 186 individuals who taught mathematics or numeracy as their primary teaching activity provided responses, either face-to-face or via the e-survey: 54% were from FE colleges and 46% from sixth-form colleges.

5 See Appendix 3 for the survey instruments.

6 The old Learning and Skills Council regions.

7 The individuals included in the analysis for this report are those teachers who identified mathematics or numeracy teaching as their primary work activity. The sample used for the analysis in the current report does not therefore include those for whom SET teaching was their primary activity but who may have undertaken some mathematics or numeracy teaching as a secondary or tertiary activity.

8 The old Learning and Skills Council regions.

SECTION 3 FINDINGS

This section has five parts. First, the scale of the challenge facing colleges to improve the mathematical attainment of those who did not achieve an A*-C in maths GCSE by the end of Key Stage 4 is examined. Second, an overview of the mathematics and numeracy teaching force in colleges is presented using the overview data collected for this report, and an estimate is made of the likely increased demand for teachers needed to deliver the policy for post-16 mathematics for those who have not achieved a mathematics GCSE at A*-C. Third, individual data collected from face-to-face interviews is used to present a description of the current FE sector mathematics and numeracy teaching workforce. Fourth, the particular challenges faced by FE colleges in implementing the post-16 mathematics policy are addressed. The final section presents data about the uptake of CPD opportunities and future requirements identified by mathematics and numeracy teachers.

3.1 RAISING MATHEMATICS ATTAINMENT 16-18: THE CHALLENGE

The scale of the challenge facing FE and sixth-form colleges in raising mathematics attainment for those aged 16-18 years who did not achieve mathematics GCSE at grades A*-C by the end of Key Stage 4 can be gauged from official statistics compiled for the year 2012/13, which relate to students completing compulsory schooling (Key Stage 4) in 2010/11[9]. At the end of Key Stage 4 in 2010/11 393,600 students passed maths GCSE at grades A*-C; 211,171 did not achieve that level of attainment. Of those 211,171 students, 147, 216 entered full-time education in school sixth-forms, special schools and colleges in 2012/13, as shown in Table 1. Clearly, the overwhelming majority of the students of interest enter FE colleges for full-time education post-16.

Table 1: Number and proportion of 16–18-year-old students not achieving A*-C maths GCSE in full-time education, by institutional type 2012/13

Institution type	Number of students	Proportion of students (%)
State-funded mainstream schools	27,398	18.6
Special schools	4,140	2.8
Sixth-form colleges	9,982	6.8
Other FE sector colleges	105,696	71.8
Total	147,216	100.0

Source: SFR 32/2014

Table 2 shows that overall, only 62% of those progressing to full-time post-16 education without GCSE mathematics at grades A*-C were entered for a mathematics qualification in 2012/13. The highest proportions of entry were in schools and sixth-form colleges, where the majority were entered for GCSE. By contrast, FE colleges not only enter a smaller proportion for mathematics qualifications post-16, but of those who are entered only about one-fifth take GCSE mathematics, compared with 70% entered for maths qualifications at Level 1 and Entry Level.

9 The statistics used come from two Statistical First Releases (SFRs). SFR 02/2012 Additional Tables 1 available at www.gov.uk/government/statistics/revised-gcse-and-equivalent-results-in-england-academic-year-2010-to-2011; SFR 32/2014 available at www.gov.uk/government/statistics/level-1-and-2-english-and-maths-16-to-18-students-2012-to-2013

Table 2: Entries in GCSE maths and other maths qualifications by 16–18-year-old students who did not achieve a grade A*-C by end of Key Stage 4 by institution type, 2012/13

Institution type	GCSE maths (%)	Maths at Level 2 (%)	Maths at Level 1 (%)	Maths at Entry Level (%)	Total entries (%)
State-funded mainstream schools	65.9	2.3	3.5	1.7	73.2
Special schools	3.5	0.5	1.9	14.4	20.2
Sixth-form colleges	56.5	9.5	11.9	4.4	82.4
Other FE sector colleges	10.9	6.9	19.9	21.2	58.8
Total	24	6	15.8	16.2	62

Source: SFR 32/2014

Table 3 then shows achievement by 16-18 students entered for different levels of maths qualification.

- Attainment in FE colleges is lower than in either school sixth-forms or sixth-form colleges. This is linked to the composition of the student body in FE colleges[10], which typically enrol students from lower socioeconomic backgrounds post-16 and with lower levels of prior attainment at the end of Key Stage 4.
- Overall the majority were attaining at Level 1 or Entry Level, particularly in FE colleges.

Furthermore, SFR 32/2014 shows that:

- 27% in schools, 40% in sixth-form colleges, and 13% in FE colleges reached a higher level of attainment in mathematics than they had previously[11].
- 36.6% in schools, 22.3% in sixth-form colleges, and 6.8% in FE colleges achieved the same level of attainment in mathematics as they had prior to starting post-16 study[12].
- 7.7% in schools, 18.0% in sixth-form colleges, and 37.5% in FE colleges achieved a lower level of qualification in mathematics than they held previously[13].

10 Elena Meschi, Claire Crawford and Anna Vignoles (2010) *Post-16 educational choices and institutional value added at Key Stage 5*. LSE: Centre for Economics of Education. Available online at http://cee.lse.ac.uk/ceedps/ceedp124.pdf. (Accessed February 2015)

11 Source: SFR 32/2014.

12 Source: SFR 32/2014.

13 Source: SFR 32/2014.

Table 3: Achievement in GCSE maths qualifications by 16–18-year-old students who did not achieve a grade A*-C by end of Key Stage 4 (2010/11), by institution type, 2012/13

Institution type	A*-C in GCSE maths (%)	Maths at Level 2 (%)	D-G in GCSE maths (%)	Maths at Level 1 (%)	Maths at Entry Level (%)	Total
State-funded mainstream schools	23.4	2.9	39.6	3.6	1.8	71.3
Special schools	0.7	0.3	2.2	1.4	14.4	19
Sixth-form Colleges	30.4	7.7	23.5	12.8	5.5	79.9
Other FE sector colleges	3.9	5.9	6.3	19.2	21.9	57.2
Total	9.2	5.3	13.5	15.3	16.9	60.2

Source: SFR 32/2014

To achieve the aspirations of current government policy embodied in the revised 16-19 study programmes[14] is going to be a significant task for the 16-19 education system, and in particular the FE colleges, who educate a much greater proportion of learners with lower levels of academic attainment at the end of Key Stage 4 than school sixth-forms and sixth-form colleges. A key principle of such study programmes is that students who have not achieved a GCSE grade A*-C by the end of Key Stage 4 in mathematics must continue to work towards achieving those qualifications, or an approved 'stepping stone' qualification towards GCSE. This is a funding condition from 2015/16, when a student studying 150 hours or more with a Grade D in GCSE mathematics or equivalent must study for the new GCSE mathematics qualification as part of their 16-19 study programme; those with lower levels of qualification undertaking 150 hours or more of learning per annum must study either for the GCSE or an IGCSE Level 1/ Level 2 certificate or another 'stepping stone' qualification such as functional skills (Entry Level to Level 2)[15].

Assuming no change in the proportion of 16-year-olds studying for more than 150 hours per annum without GCSE mathematics at grade A*-C by the end of Key Stage 4, that would mean providing mathematics learning at an appropriate level for about another 50,000 learners[16] each year in FE colleges, that is another 220 learners per FE college on average. The equivalent estimate for sixth-form colleges would be around 1,800, another 30 or so learners per college on average. Clearly this expansion in learner numbers is going to require increased recruitment of suitably qualified mathematics and numeracy staff, and the professional development of the new and existing mathematics and numeracy teachers.

14 Professor Alison Wolf, in her *Review of vocational education* (2011) recommended that study programmes be introduced to offer students breadth and depth, without limiting their options for future study or work. These were introduced in August 2013.

15 See Wolf review of vocational education: government response available online at www.gov.uk/government/publications/wolf-review-of-vocational-education-government-response; 16 to19 study programmes available online at www.gov.uk/government/uploads/system/uploads/attachment_data/file/343147/16_to_19_study_programmes_departmental_advice.pdf

16 In 2012/13, 120,000 16/17-year-old learners enrolled in other FE sector colleges who had not attained a GCSE Grades A*-C by the end of Key Stage 4. Of these 58.7% were entered for a mathematics qualification: about 70,000 learners. Thus, the remainder, 120,000 – 70, 000 = 50,000 will need to be entered for mathematics qualification in the future. Data SFR 32/2014.

Most of the students entering FE colleges without GCSE mathematics qualifications at A*-C, will, if current patterns prevail, be studying for Level 1 and Entry Level maths qualifications such as Functional Skills, and will be drawn from more disadvantaged backgrounds than learners entering either school sixth-forms or sixth-form colleges[17]. Teaching and helping young people with such prior attainment in mathematics, and from disadvantaged backgrounds, to achieve meaningful mathematics qualifications will be very challenging. It is obviously important to be aspirational for learners who have not developed the level of mathematical proficiency needed to gain and maintain decent employment in the UK economy, but the challenge in terms of the numbers of teachers needed, their required level of mathematical knowledge, and their expertise in helping students to attain must not be under-estimated.

The next section seeks to estimate the number of extra teachers that will be required to deliver the level of additional learning programmes required by current policy.

3.2 THE DEMAND FOR TEACHERS

Using the overview data collected from the FE and sixth-form colleges, Table 4 presents estimates of the average and total number of mathematics and numeracy teachers in FE colleges. In sixth-form colleges, no distinction was made by respondents to the survey between mathematics and numeracy teachers; this is most likely because the proportion of those taking numeracy courses in sixth-form college rather than say A-level or GCSE is quite low[18] compared with FE colleges. Further, it is likely that learners in sixth-form colleges taking functional skills qualifications are taught by the mathematics teaching team, rather than by a numeracy team as part of Foundation programmes, as may be the case in FE colleges.

Table 4: Nationally projected number of mathematics and numeracy teachers in English FE and Sixth-form colleges, by contract type

	Mathematics ±95% CI				Numeracy ±95% CI			
	Full-time	Part-time	Total	Full-time equivalent total	Full-time	Part-time	Total	Full-time equivalent total
FE colleges	820 ±165	720 ±195	1450 ±265	1180 ±235	920 ±209	850 ±340	1690 ±425	1270 ±330
Sixth-form colleges	550 ±85	270 ±65	820 ±105	720 ±85				

Source: Overview survey for this report

17 Elena Meschi, Claire Crawford and Anna Vignoles (2010) *Post-16 educational choices and institutional value added at Key Stage 5*. LSE: Centre for Economics of Education. Available online at http://cee.lse.ac.uk/ceedps/ceedp124.pdf. (Accessed February 2015)

18 Estimated at 7% of all learners taking mathematics qualifications in 2012/13 in sixth-form colleges, compared with 40% in FE colleges. See Table 5.

To assess the future demand for mathematics teachers requires first an estimate of the number of learners taking mathematics in FE and sixth-form colleges. For 2012/13 these can be taken from three Statistical First Releases[19]. Using these data and making the following assumptions, an estimate of the total number of learners taking mathematics qualifications in 2012/13 can be obtained.

- All those who studied for GCE A-level mathematics qualifications were entered for the examination, so that the number of entries recorded in SFRs 02/2014 and 03/2015 equals the number of students studying GCE A-level mathematics in year 13 and year 12 in 2012/13. This is likely to be an under-estimate, but it will be conservative and accurate enough for our purposes.
- All entered for A-level mathematics were entered in year 13.
- All those studying for Further Mathematics were also studying for A-level mathematics.

Table 5 provides an estimate of the number of learners studying for mathematics qualifications in FE sector colleges in 2012/13. This shows the sharp difference in the level of qualification being taken by learners in the two types of colleges.

Table 5: Mathematics qualifications being taken in 2012/13 by learners in sixth-form and FE colleges

	GCE A-level year 13[1]	GCE A-level year 12[2]	GCSE[3]	Other[3]	Total
Sixth-form colleges	14,000	13,700	6,400	2,500	36,600
Other FE colleges	5,400	5,100	13,100	57,400	81,000

Source: 1 = SFR 02/14; 2 = SFR 03/2015; 3 = SFR 32/104

The teachers identified in Table 4 are teaching these learners: a total of 720 FTEs in sixth-form colleges and (combining the estimated numbers for mathematics and numeracy) 2,450 FTEs in other FE colleges. This suggests a staff:student ratio in FTEs of about 1:51 in sixth-form colleges and 1:33 in FE colleges. The value is higher for sixth-form colleges, most probably because mathematics teachers in these colleges mainly teach GCE-level, whereas the FE college teachers are mainly teaching numeracy programmes.

Teaching an extra 1800 learners mathematics in sixth-form colleges would require an estimated extra 36 FTEs, about 0.5 FTE per college on average. This is likely to be an under-estimate as the extra learners, who would have lower levels of attainment at GCSE, would require smaller class sizes to meet their learning needs. Assuming the staff:student ratio was similar to that found in other FE colleges (1:33) this would equate to about 55 FTEs, on average just under 1 teacher per sixth-form college. By contrast, the extra 50,000 learners estimated to require mathematics instruction, as part of their 16-19 learning programmes in FE colleges, would need such colleges to hire an extra 1500 FTEs, on average about 6.5 FTEs per college. The vast majority of these staff would be teaching numeracy programmes rather than GCSE mathematics, but nonetheless hiring this number of staff will be a significant challenge.

19 SFR 32/104 Level 1 and 2 attainment in English and Maths by students aged 16-18: academic year 2012/13; SFR 02/2014 A-level and other level 3 results: academic year 2012/13 (revised); SFR 03/2015 A-level and other level 3 results: academic year 2013/14 (revised).

3.3 THE DEMOGRAPHIC CHARACTERISTICS, QUALIFICATIONS AND EXPERIENCE OF FE SECTOR MATHEMATICS AND NUMERACY TEACHERS

The analysis in this section employs data from the face-to-face and e-surveys undertaken with FE and sixth-form college teachers. Individuals in the sample variously described themselves as Lecturers, Senior Lecturers, Teachers, Tutors or Other. From the job titles given, the 'Other' category consisted of curriculum and other types of college managers, so they were assigned the title 'Manager'. There was no significant difference[20] in the number of class contact hours between teachers, senior teachers and tutors, so they were further collapsed for analytical purposes into a single category of teachers: the three individuals describing themselves as tutors were effectively part-time college teachers on sessional contracts. On average, teachers on full-time contracts taught for around 22 hours per week (contact hours), while full-time managers typically taught for about 20 hours per week. Part-time staff taught typically for about 16 hours per week.

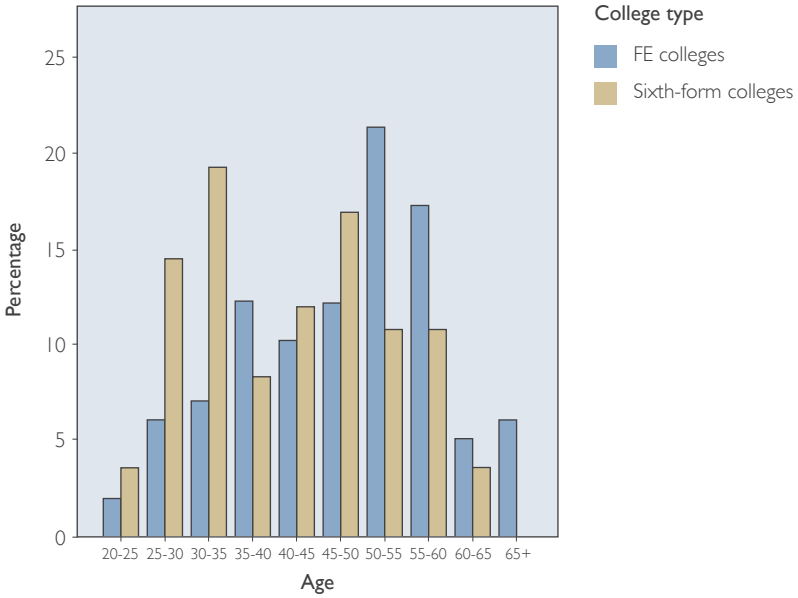
Age profile

Figure 1 shows the overall age profile of the sample disaggregated by college type. The mean age for both types of college is similar: 42.6 years in FE colleges and 41.6 years in sixth-form colleges. However, it is clear from inspection of Figure 1 that the most frequent (modal) age for FE college mathematics teachers is 50-55, but 30-35 for sixth-form college mathematics teachers. The median age of the sample of mathematics teachers in the sixth-form colleges, at 40, is lower than that for FE college teachers at 48. In FE colleges, 28.5% of mathematics teachers in the sample are aged 55 or over, compared with 14.4% in sixth-form colleges[21].

20 One way ANOVA LSD post hoc test. Managers had significantly fewer teaching contact hours on average than teachers.

21 This figure for FE colleges derived from data collected for this report compares well with that from the SIR for all FE college teachers where 24% were aged 55 or over. Further, in FE colleges, nearly half of the mathematics teachers in this sample were aged 50 or over, compared with 23.2% in sixth-form colleges.

Figure 1: Age distributions of the FE and sixth-form college mathematics teaching workforce (n=123)



Thus, in addition to the expansion demand identified in the previous section, there will likely be an extremely high demand for new, well-qualified mathematics teachers in FE colleges, simply to meet replacement demand deriving from retirement over the next ten years. Recruiting enough well-qualified mathematics teachers, and upskilling the current teaching force to meet the expected expansion plus replacement demands, will be a severe challenge when current forecasts indicate, for example, that recruitment to mathematics initial teacher training programmes is, at best, only likely to match the replacement demand for school teachers[22]. Whether the golden hello of £7,500 for mathematics teachers in FE colleges announced in 2014[23] will be a sufficient incentive to meet demand can only be assessed in the future.

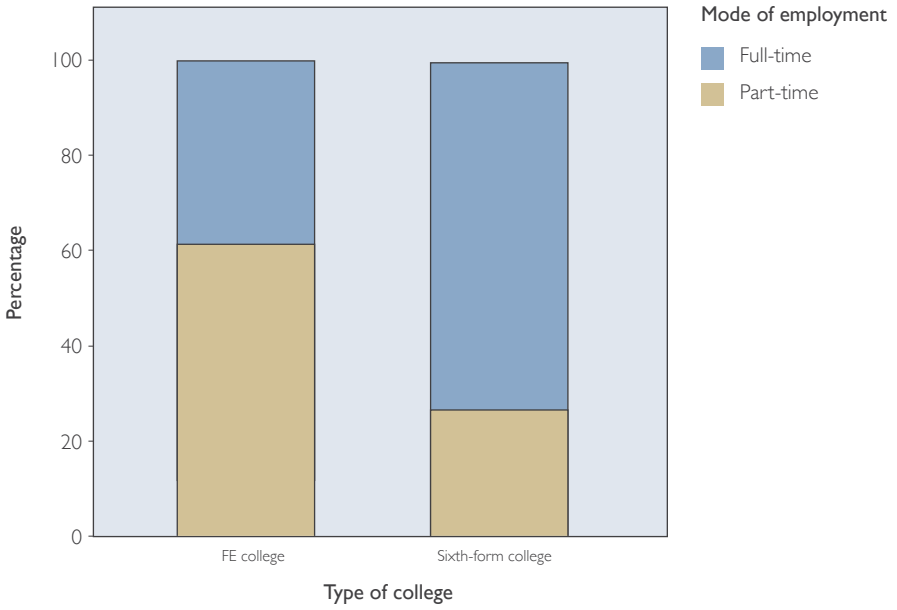
22 John Howson mathematics report to be published by the Nuffield Foundation (title and publication date to be confirmed).

23 www.gov.uk/government/uploads/system/uploads/attachment_data/file/321425/golden-hello-guidance.pdf

Contract types

Figure 2 shows the employment-contract type disaggregated by type of college. Clearly within this sample there are a significantly higher proportion of staff teaching mathematics and numeracy programmes in FE colleges working part-time than in sixth-form colleges: 62.2% of FE mathematics teachers were working part-time compared with 28.8% in sixth-form colleges[24]. The reasons for this difference are not clear, but may reflect the challenges that FE colleges have in recruiting enough full-time staff and/or the appetite of FE college managers for employing part-time staff to maintain flexibility in the FE college workforce. The type of employment contract may be of importance when considering the delivery of CPD to upskill teachers needed to meet the aspirations of the government's post-16 mathematics policy. For full-time staff, undertaking CPD may be considered part of their contract of employment; part-time staff may have to be paid extra to attend such training, and this may be a cost which colleges will find challenging to bear.

Figure 2: Mode of employment by college type (n= 124)



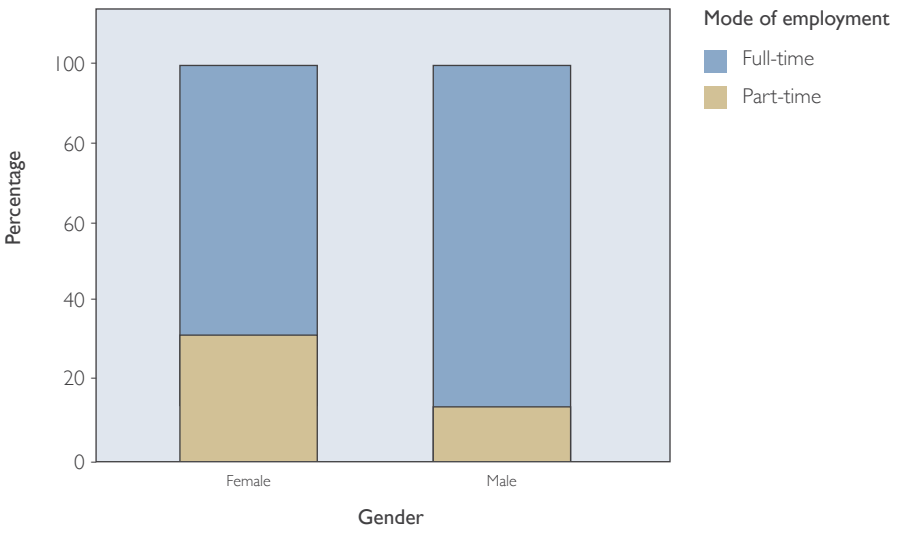
24 $\chi^2 = 20.04$, df = 1, $p<0.05$. The odds of working part-time as a maths teacher in FE are 4.1 times the odds of working part-time in a sixth-form college.

Gender differences

There are slightly more female mathematics teachers in sixth-form colleges than in FE colleges (53% and 50%, respectively) but the difference is not significant[25]. The proportion of female science and mathematics teachers provided from the SIR is 55%, suggesting that the sample constructed for this report is reasonably representative.

Figure 3 shows the distribution of contract type by gender. No direct comparison should be made here between the proportions of men and women working on part-time contracts and the figures given in the previous section, because of the large number of missing values for gender. Women are significantly[26] more likely to be working part-time than men, which is consistent with the findings from the analysis of the SIR. On the basis of the data in this sample, female mathematics teachers in sixth-form colleges are slightly more likely to be working part-time than their colleagues in FE colleges, 33% and 28% respectively. This may be linked to the differences in age of the two groups: the median age of female mathematics teachers in sixth-form colleges is 41, compared with 51 in FE colleges.

Figure 3: The proportion of male and female mathematics teachers working full- and part-time in the FE sector (n= 124)



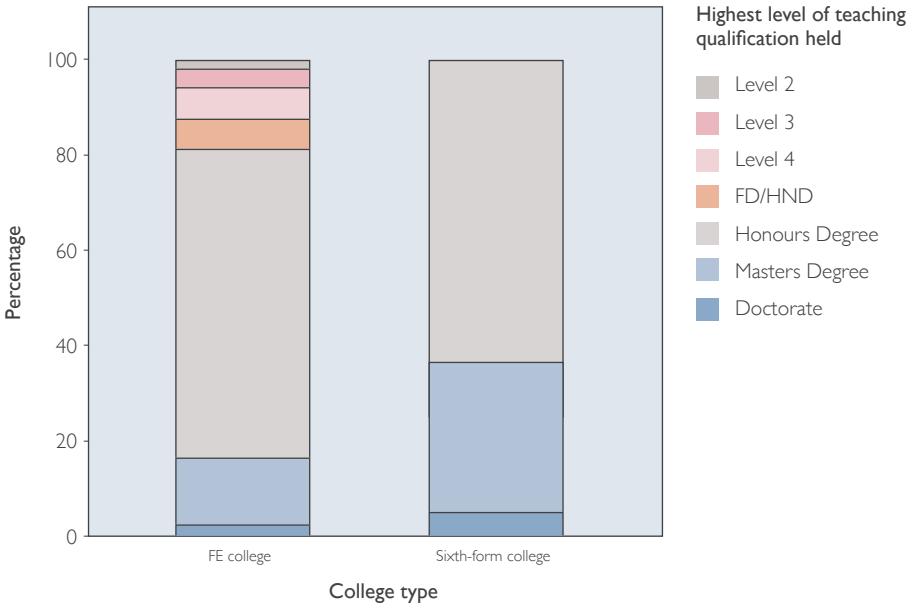
25 $\chi^2 = 0.09$, df = 1, p>0.05

26 $\chi^2 = 5.7$, df = 1, p>0.05, women are three times more likely than men to be working part-time.

Qualifications

Figure 4 compares the levels of highest non-teaching qualifications held by the mathematics workforce in the sample, disaggregated by college type. All the mathematics staff teaching in sixth-form colleges have degrees or higher qualifications, whereas staff teaching mathematics in FE colleges have a much wider range of academic or vocational qualifications, with 81.7% of those teaching mathematics in FE colleges having degrees or higher qualifications. The Education and Training Foundation (ETF) sponsored analysis of *The qualifications of English and mathematics teachers* provides a lower value for FE colleges, with only around 50% of mathematics teachers reported to be holding degrees[27].

Figure 4: The highest level of non-teaching qualification held by the mathematics teaching workforce by type of college (n= 124)

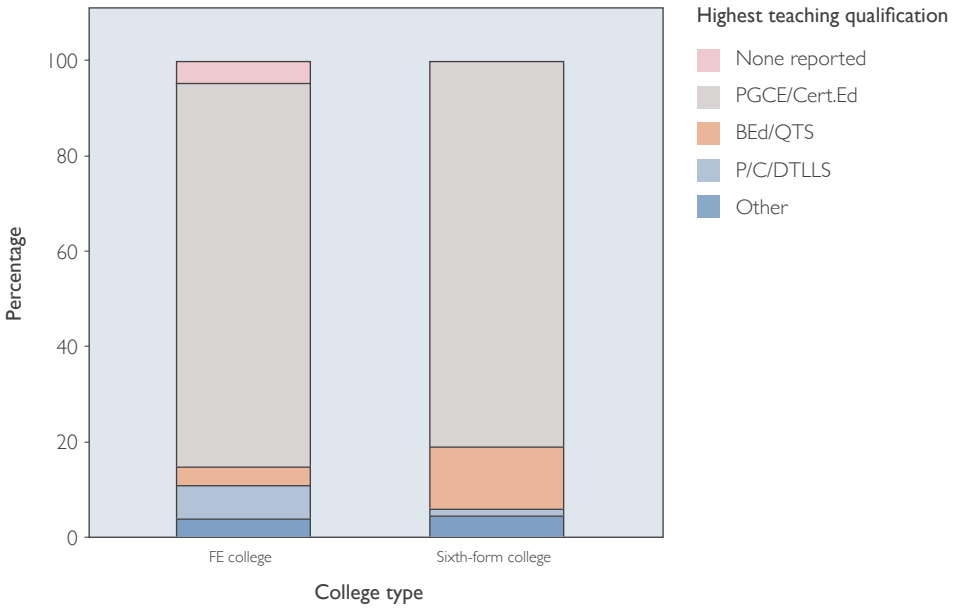


27 This ETF analysis is based on data from the *Strategic Consultation: Mathematics and English Survey*. This is an e-survey conducted across the whole of the sector not just FE colleges. Thus, the survey would have included other types of provider not just FE colleges reported here. The ETF analysis also reported that younger teachers were less well-qualified than older ones. This seems to be the case in the sample generated for this report: there is some evidence that those aged 40–50 are the most likely to have a degree or higher qualification such as a Masters or a Doctorate degree. Those aged 60 or over in this sample were the least likely to hold a degree.

In terms of teaching qualifications (Figure 5), there are only minor differences between the level of qualification of teachers and managers teaching mathematics in the two types of college within this sample:

- 72% of FE staff teaching mathematics had PGCEs compared with 78.3% in sixth-form colleges;
- Adding in Cert Eds, 82.8% of FE staff had either this qualification or a PGCE compared with 80.7% of sixth-form college staff;
- 85% of FE staff had a BEd, CertEd, or PGCE teaching qualification, compared with 86.7% of those in the sixth-form colleges;
- Together, 88.2% of FE staff had qualifications that would confer Qualified Teacher Status compared with 93.5% of those in the sixth-form colleges.

Figure 5: Highest teaching qualification held by type of college (n=124)

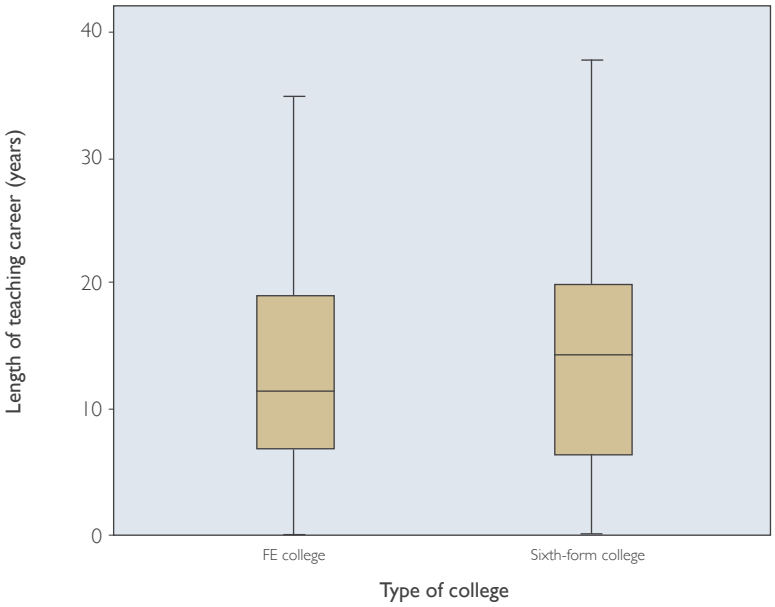


Experience

Experience of both teaching and industrial experience may substitute for qualifications when it comes to teaching a mathematics course. As Figure 6 indicates, in terms of teaching experience there is no significant difference[28] between mathematics teachers in the two types of colleges: on average in a FE college individuals have been teaching for 15.2 years compared with15.5 years for sixth-form college mathematics teachers. Thus, despite their greater median age, FE college teachers, on average, have not accumulated more years of teaching experience than their sixth-form college colleagues.

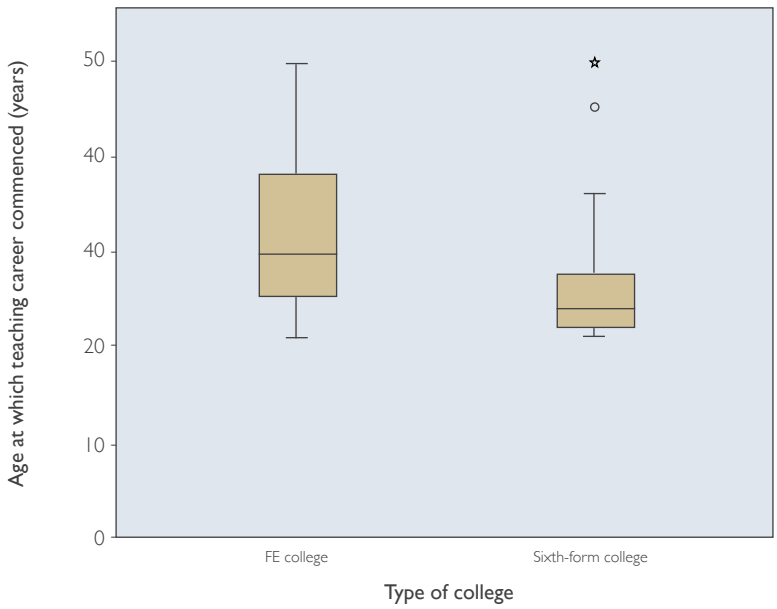
28 F = 0.46, df = 1, 179, p>0.05

Figure 6: Median length of teaching career by type of college (n=124)



This, as Figure 7 shows, is because in this sample FE college teachers of mathematics and numeracy tend, on average, to start their teaching careers significantly[29] later than their sixth-form college counterparts: the typical FE college teacher starts teaching at an average age of 31.5 years compared with 25.4 years for a sixth-form college teacher.

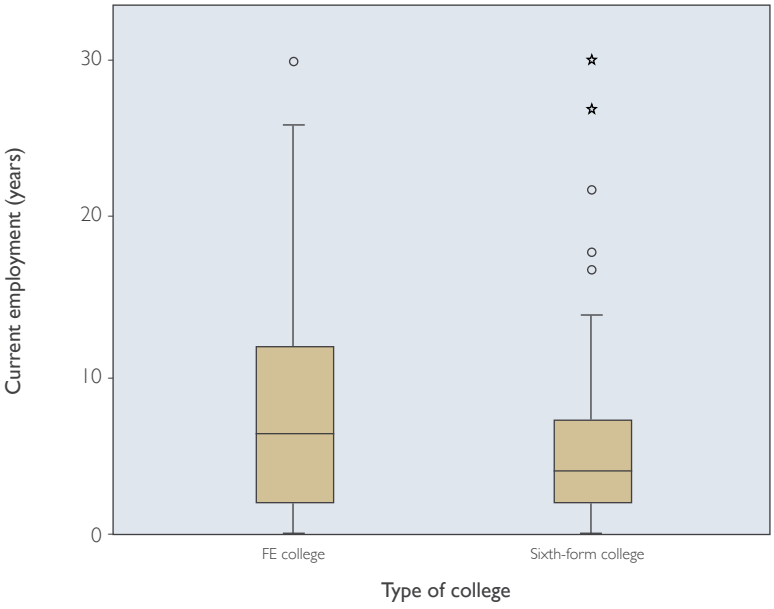
Figure 7: Median age of commencement of a teaching career by type of college (n=124)



29 F = 23, df = 1, 121, p<0.05

Essential knowledge for effective teaching includes understanding the context and situation you find yourself teaching in, and this depends upon spending time in a college to learn, for example, its routines, systems and processes. A rapid turnover of staff is not conducive to such learning, and imposes a cost in inefficiency and training costs associated with induction. As Figure 8 shows, FE college teachers tend on average to have been in their current post slightly longer than their sixth-form college contemporaries, 8.5 years compared with 6.9 years, but this difference is not significant[30].

Figure 8: Median length of current employment (years) by type of college (n=124)



The reason for the later onset of teaching as a career amongst FE college teachers is the longer period they have spent working in industry linked to their vocational and professional pathways to teaching mathematics, for example via engineering and science. Thus, FE college staff teaching mathematics are significantly[31] more likely to have had relevant industrial experience (59%) compared with their sixth-form college counterparts (39%). Furthermore, those FE college teachers of mathematics with relevant experience have spent, on average, twice as much time[32] (12.2 years vs 5.4 years) working in industry or business as their sixth-form college counterparts. The extent to which this accrued experience can substitute for formal qualification is impossible to estimate objectively. However, of the 52 individuals who answered the question, 73% stated that their industrial experience was useful or very useful in teaching their mathematics courses. Such experience may be invaluable in making mathematics relevant to the real world for young people who may be more reluctant learners of mathematical content.

30 $F = 3.3$, $df = 1, 167$, $p>0.05$

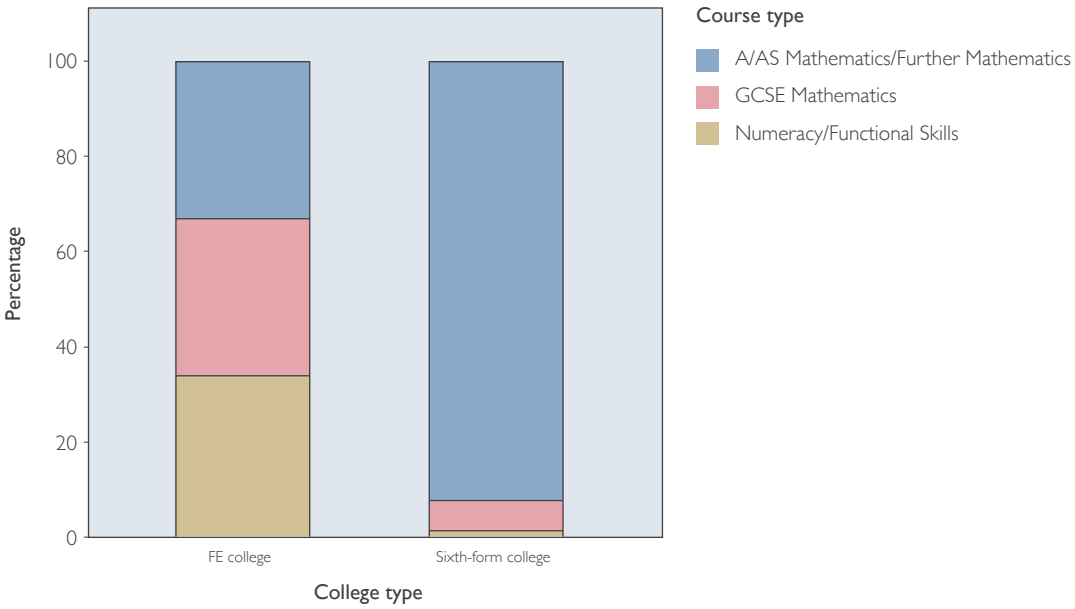
31 $\chi^2 = 5.5$, $df = 1$, $p<0.05$; FE college mathematics teaching staff are 2.3 times more likely to have had relevant industrial experience than their sixth-form college counterparts.

32 This is a significant difference: $F = 13.7$, $df = 1, 66$, $p<0.05$

Courses taught

Unsurprisingly, differences in the academic and industrial background of the respective workforces are linked to the courses they teach. Figure 9 shows the types of mathematics and numeracy courses being taught by the teachers in the sample in the two types of colleges, by collapsing A-level and AS-level mathematics and further mathematics into one category, and a plethora of numeracy and functional skills programmes into another. This figure echoes Table 5, with a greater diversity of mathematics programmes being taught in FE colleges; sixth-form colleges specialise in the teaching of GCE A-level mathematics with a much smaller percentage retaking GCSEs. Sixth-form college teachers are 24.7[33] times more likely to be teaching GCE A-level than their FE college colleagues; FE college teachers are 5.9 times more likely to be teaching GCSE and 45.6 times more likely to be teaching numeracy/functional skills than their sixth-form college colleagues.

Figure 9: Proportion of different types of mathematics and numeracy/functional skills course taught by college type (n=124)



In the future, the likelihood is that sixth-form colleges will have to teach a greater proportion of their learners GCSE mathematics and courses leading to 'stepping stone' qualifications. However, it is the FE colleges where the main challenge of teaching mathematics to GCSE level and below to a diverse array of learners[34], both young people and adults, will most likely fall. Consequently the next section focuses on the workforce and the courses that they teach in FE rather than sixth-form colleges.

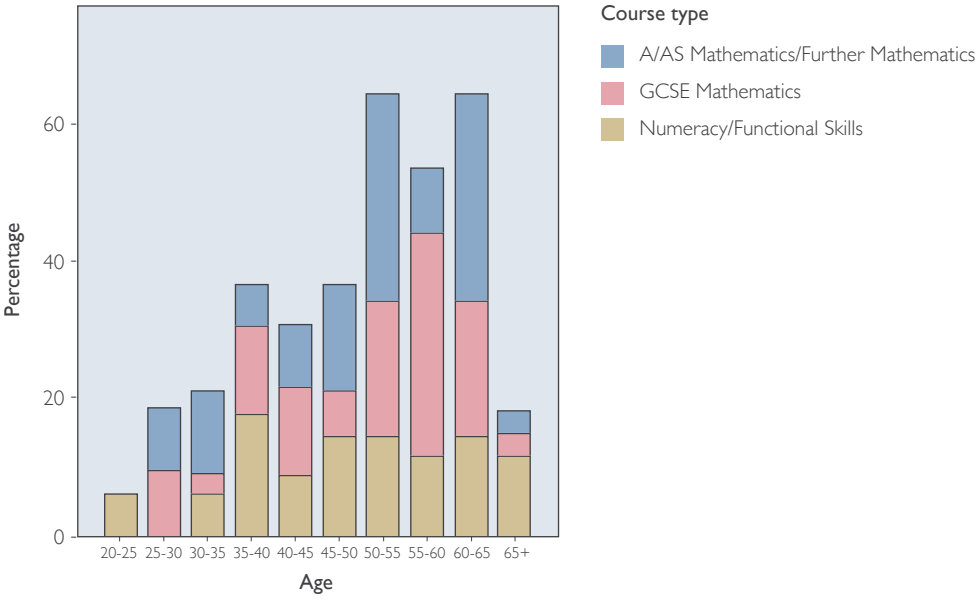
33 These values are all odds ratios. The significance of the association within the contingency table is $\chi^2=64.2$, df=2, $p<0.05$

34 See: http://cee.lse.ac.uk/ceedps/ceedp124.pdf
Pupils from lower socio-economic status (SES) backgrounds and with poorer qualifications tend to be found in FE colleges rather than school sixth-forms and sixth-form colleges.

3.4 THE CHALLENGE FOR FE COLLEGES

A clear challenge for FE colleges will be meeting both replacement and expansion demand for mathematics, given that nearly 50% of their current mathematics teachers are aged 50 or over. Figure 10 shows the age distribution of individuals teaching different types of mathematics course in FE colleges. First note the skewed nature of the distribution, reflecting the older median age of FE college mathematics teachers. Disaggregating by course type, there are no significant differences[35] in the average ages of FE staff teaching the three types of programme shown in Figure 10. However, in such skewed distributions the median is a better measure of a typical teacher than the mean. Those teaching GCSE as their primary activity have the highest median age (51 years) while those teaching numeracy and functional skills have the lowest (45 years). GCE A-level mathematics teachers fall in an intermediate position (47.5 years). Thus, on the basis of the evidence from this sample, while replacement demand for mathematics teachers in FE colleges will in general be high over the coming years, it is likely to be slightly more acute for those currently teaching GCSE as their primary activity.

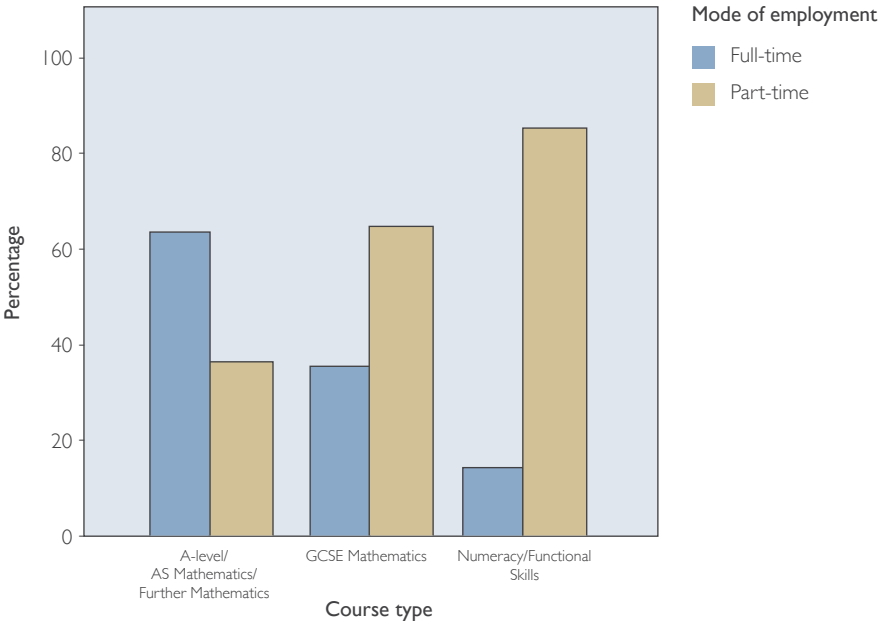
Figure 10: Age distribution of teaching workforce for different mathematics courses in FE colleges (n= 49)



35 F = 0.14, df = 2, 90, p>0.05

Figure 11 shows mode of employment of FE college teachers across different types of mathematics and numeracy programmes. Just under two-thirds of those in the sample teaching GCE A-level programmes worked full-time, compared with just over a third teaching GCSE. The majority of those teaching on numeracy and functional skills courses, 85.3%, worked on a part-time basis. Within the FE sector you are 7 times more likely to be employed on a full-time basis if you teach GCE A-level mathematics than if you teach GCSE mathematics and numeracy/functional skills. Yet in terms of teaching future learners of mathematics, it is most likely that the greatest growth will be in GCSE and numeracy programmes, i.e. the load will fall primarily on part-time staff if this picture of employment contracts persists into the future.

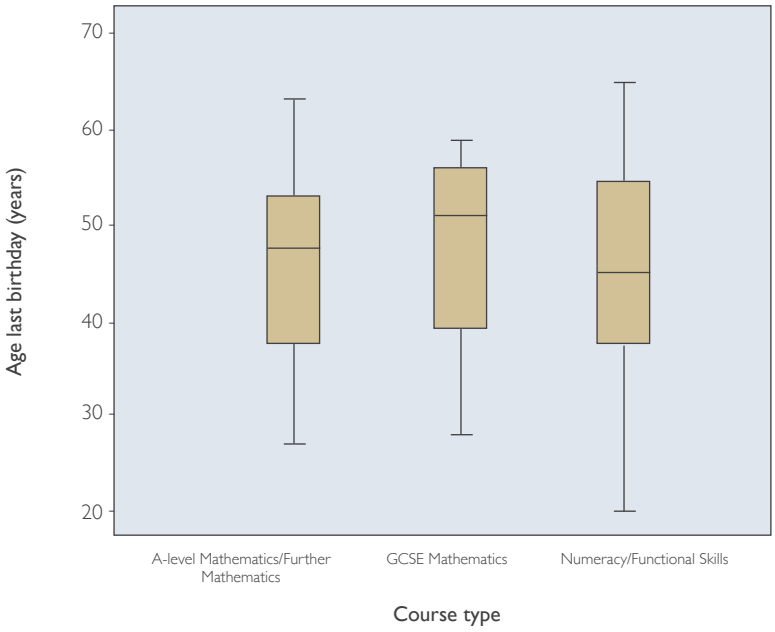
Figure 11: Course type by mode of employment of teachers in FE colleges (n=50)



However, it is not the case in this sample that the part-time workforce has less experience or faster turnover rates than those working full-time. For example, on average full-time staff teaching mathematics and numeracy in FE colleges have 14.6 years of teaching experience, compared with 14.3 years for part-time staff. Full-time teachers have held their current posts for, on average, 7.7 years while the part-timers have been in their current post for 8.8 years on average.

Figure 12 compares the length of teaching experience of FE college staff across different types of mathematics programmes. The horizontal line in each box is the median age. There is some slight but insignificant variation in the median age of individuals teaching different types of numeracy programmes in FE colleges. Part-time teaching staff seem, therefore, to be very similar to their full-time counterparts in terms of their teaching experience and attachment to a particular FE college. They do not appear to be a highly mobile workforce but more likely a group of teachers who have chosen to work part-time, perhaps in order to meet other commitments. This attachment to the colleges they work in means that they are likely to have developed the sort of situational knowledge necessary to underpin effective teaching.

Figure 12: Age distributions of FE college teachers across different types of mathematics course (n=50)



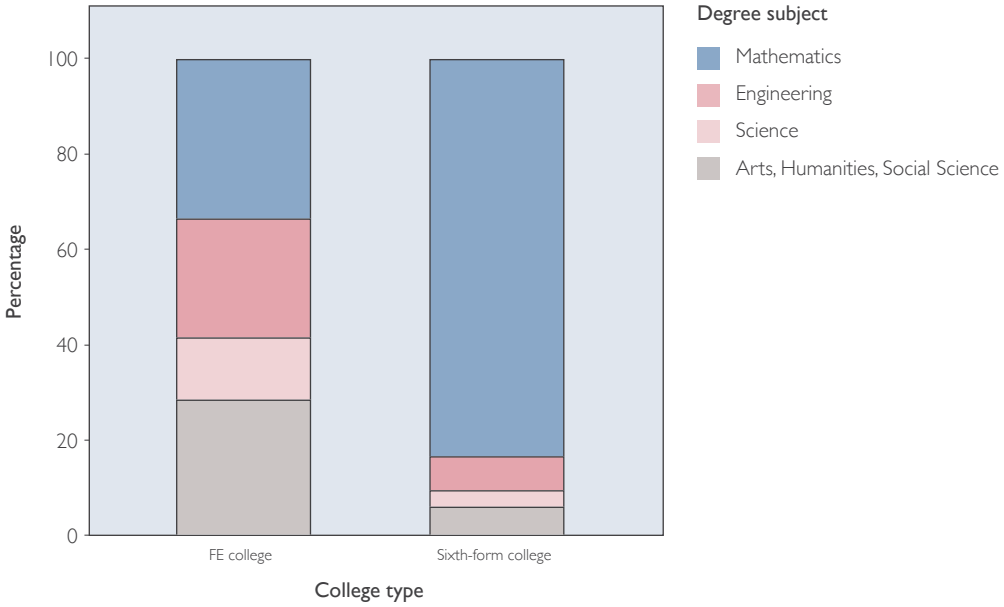
However, current policy documents suggest that to teach Foundation level numeracy programmes requires a Level 5, i.e. Foundation Degree, qualification in mathematics.

'In 2012 Lord Lingfield reported on Professionalism in Further Education, and his independent review panels recommended that those teaching Foundation literacy and numeracy or teaching students with SEN should be qualified to Level 5. The Government supports this as the minimum standard of teaching in FE, but it is for FE providers to decide for themselves the appropriate qualifications required for each position.'[36]

36 Department for Business Innovation and Skills (2014) *Further Education Workforce Strategy: The Government's strategy to Support Workforce Excellence in Further Education*, p. 13.

Evidence from this sample suggests that achieving this outcome is likely to be a major challenge if the reference to Level 5 implies a Level 5 mathematics qualification. As shown in Figure 13, the types of degrees held by FE and sixth-form college mathematics teachers differ significantly. For example, of those with Level 6 or higher qualifications, those working in sixth-form colleges were significantly more likely to have mathematics degrees compared with those in FE colleges[37].

Figure 13: Type of degree held by mathematics teachers by college type (n=107)



37 $\chi^2 = 43.9$, df = 3, $p<0.05$

Figure 14 shows the highest qualifications held by FE college teachers across different mathematics programmes. Clearly GCE A-level mathematics in FE colleges and GCSEs are overwhelmingly taught by those with degrees or higher-level qualifications, 97% and 93.5% respectively. Only 3% of those teaching mathematics GCSE have a highest qualification below Level 5. Among individuals teaching on the foundation numeracy and functional skills programmes in this sample, 56% hold degrees or higher levels of qualification. However, almost 30% teaching these programmes hold no qualifications above Level 4.

Figure 14: Highest qualifications held by teachers of mathematics and numeracy in FE colleges by course type (n=50)

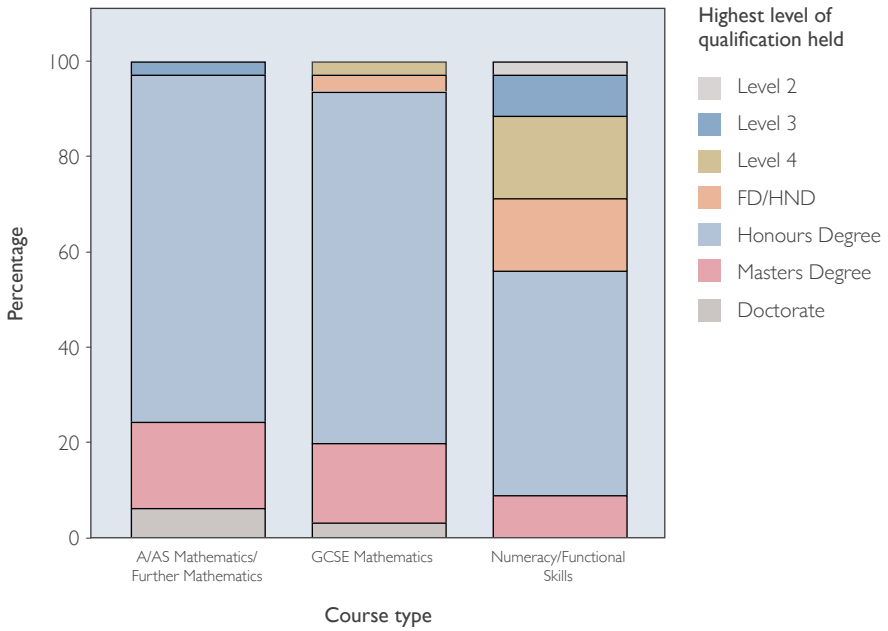
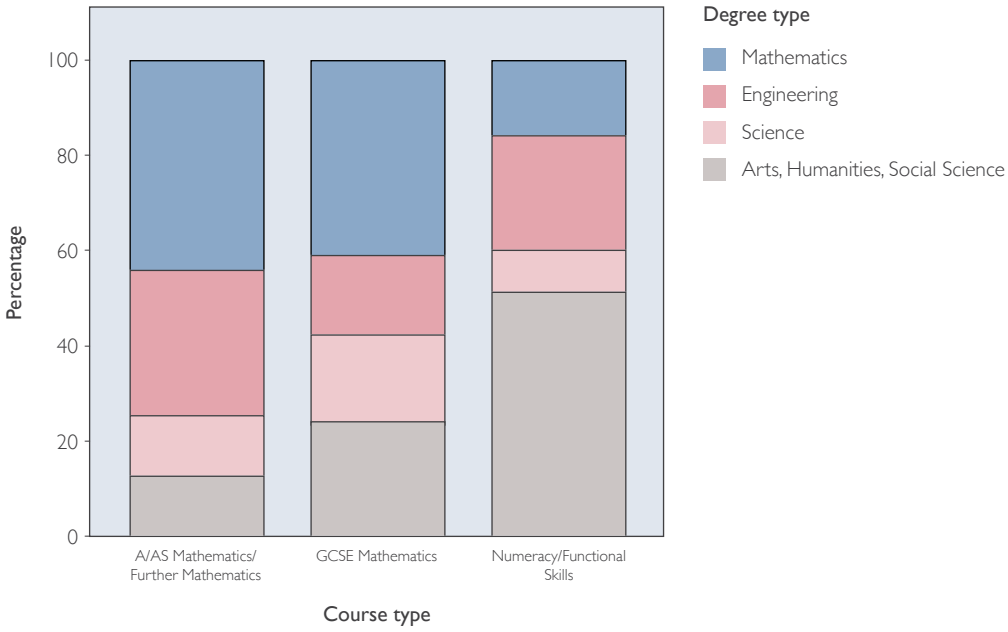


Figure 15 shows the different types of degrees held by FE college teachers across different types of mathematics programme. This disaggregation reveals a more worrying picture. Amongst those teaching A-level mathematics, 44% have a degree in mathematics, 31% a degree in engineering, and 12.5% a degree in science, disciplines with a sizeable mathematics component. However, 12.5% have an Arts, Humanities or Social Science degree. Amongst staff teaching GCSE the proportion doing so with an Arts, Humanities or Social Science degree has almost doubled to 23.3% in this sample. Amongst those in this sample teaching GCSE and numeracy/ functional skills without a mathematics degree, 43% do not have an A-level or equivalent in mathematics: their highest mathematics qualification is GCSE Grade A*-C (or the equivalent), which is held by 96%. This finding resonates with that from the ETF report *The qualifications of English and maths teachers*.

'Teachers typically have subject qualifications at least one level above the level they reach. However, based on the data from the Strategic Consultation Survey, 12% of those teaching GCSE mathematics … only have highest qualifications to the same level taught. Moreover, based on the data from the GCSE Maths Analysis, there is evidence that some teachers (9%) teaching at GCSE mathematics level, possess only functional or basic skills Level 2 qualifications. This indicates that in some instances teachers may lack adequate qualification with respect to the level they teach.'

Figure 15: Type of degree held by FE college teachers across different types of mathematics programmes (n=50)



Over half of the teachers, 52%, who hold a degree and teach numeracy and functional skills programmes do so with Arts, Humanities or Social Science degrees. Such degrees may contain a sizeable amount of mathematical content, for example economics, but this is likely to be biased towards statistics rather than pure mathematics which will inevitably form a large component of the new GCSE. This analysis suggests, therefore, that there are serious questions which require further investigation about the level of mathematical subject content knowledge held by those who are currently employed within FE colleges to teach mathematics, and how this might be raised. Initiatives are in place to support mathematics subject knowledge enhancement[38] and these need careful evaluation. Nonetheless, to reach the benchmark of all those teaching mathematics programmes at GCSE level to be qualified to Level 5 in mathematics is going to be a huge challenge. The evidence is that having this level of qualification is necessary to provide teachers with the confidence needed to teach mathematics effectively, particularly to answer students' questions and to deal with misconceptions[39].

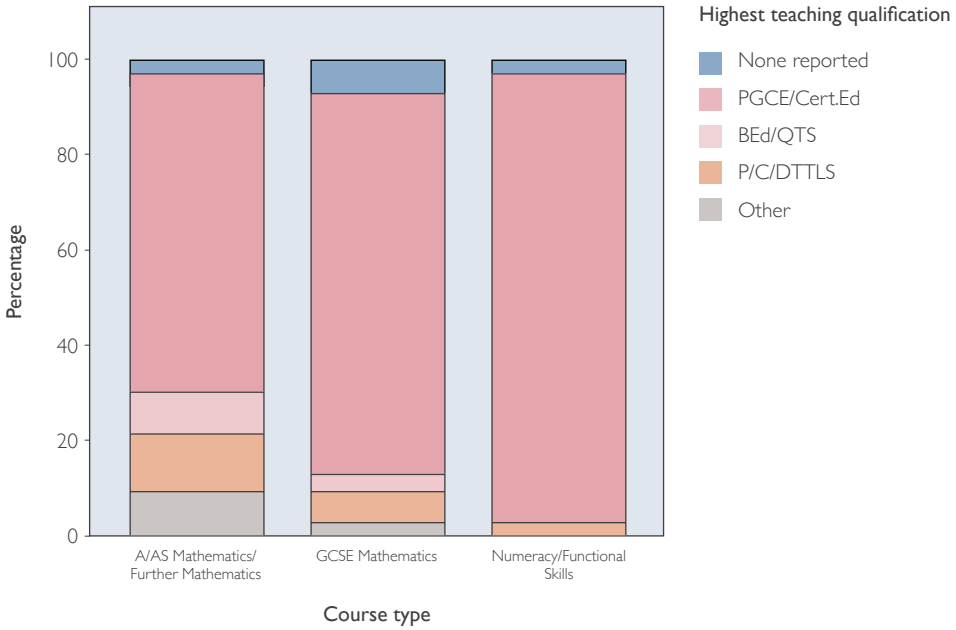
38 For example, the National Centre for Excellence in the Teaching of Mathematics (NCETM) is working in partnership with the Centres for Excellence in Teacher Training (CETTs) and the Education and Training Foundation (ETF) to establish high quality CPD provision for teachers of mathematics in the Further Education (FE) and skills sector. The NCETM GCSE Mathematics Enhancement Programme is a key part of this provision. It will enable teachers who are already involved in numeracy or functional skills teaching to enhance their knowledge so that they can teach GCSE effectively'. www.ncetm.org.uk/resources/41310

39 ETF (2014) *The qualifications of English and mathematics teachers.* Available online at www.et-foundation.co.uk/wp-content/uploads/2014/09/RPT-Survey-v4.pdf

Teaching mathematics and numeracy to students who have completed compulsory education without achieving a satisfactory level of attainment in mathematics will also provide an additional challenge: supporting the learning of young people who are likely to have motivational issues in learning a subject which they had hoped to be able to give up, and in some cases with special educational needs. Having a good level of mathematics knowledge is therefore a necessary but not sufficient condition to teach such young people effectively and enable them to achieve. It also requires well-trained teachers with the requisite pedagogic skills and strategies to engage and motivate young people to learn demanding mathematics content.

Figure 16 shows the highest teaching qualification held by FE college teachers of mathematics and numeracy courses. Only 4% of the sample reported having no teaching qualifications, with 80% having a PGCE or Cert Ed. Interestingly, those teaching the numeracy and functional skills programmes are the most likely to have a PGCE or Cert Ed. This potentially indicates a high level of teaching proficiency amongst this workforce. Ofsted reports[40] nonetheless continue to report weaknesses in the teaching of mathematics in FE colleges but this may be due, at least in part, to a lack of subject knowledge and the confidence that flows from feeling knowledgeable in a subject domain, rather than teaching skills per se. The analysis so far points to the need for considerable investment in continuing professional development, and this is discussed in the next section.

Figure 16: Highest teaching qualification by course type in FE colleges (n=50)

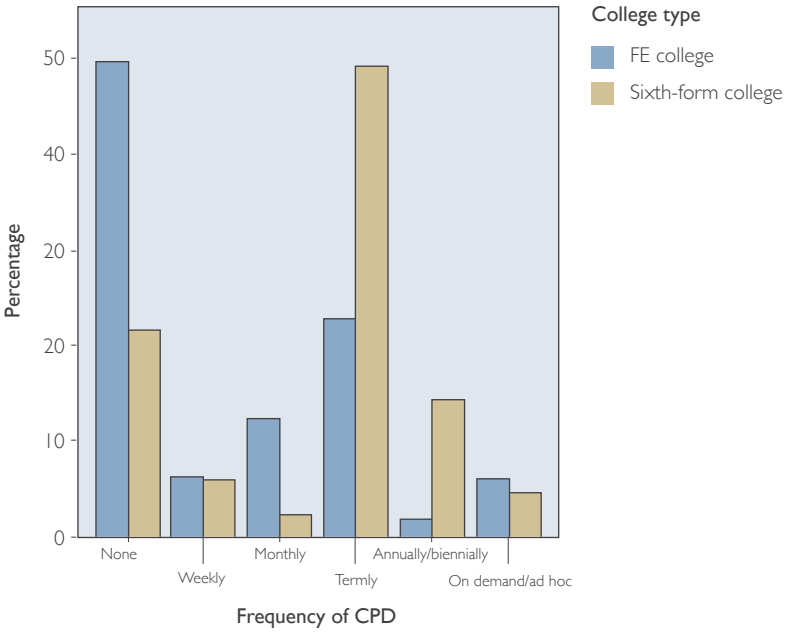


40 www.oftsed.gov.uk/resources/ofsted-annual-report-201213-further-education-and-skills

3.5 CONTINUING PROFESSIONAL DEVELOPMENT (CPD)

Government policy[41] clearly recognises the importance of CPD, and signals a commitment to resource the development of the existing teaching workforce, as well as supplying inducements, such as bursaries, to attract new mathematics teachers into the FE sector. Figure 17 provides an indication of the current frequency of CPD activities made available on a regular basis for mathematics teachers in this sample, disaggregated by college type. Clearly teachers are significantly more likely to receive some CPD on a regular basis if they are in a sixth-form as opposed to a FE college. For those receiving some regular CPD the most common pattern is monthly or termly: 70.8% in FE colleges and 64.2% in sixth-form colleges. A higher proportion of teachers of mathematics in sixth-form colleges receive annual CPD opportunities, often coinciding with the summer examination periods.

Figure 17: Frequency of participation in CPD by college type (n=124)

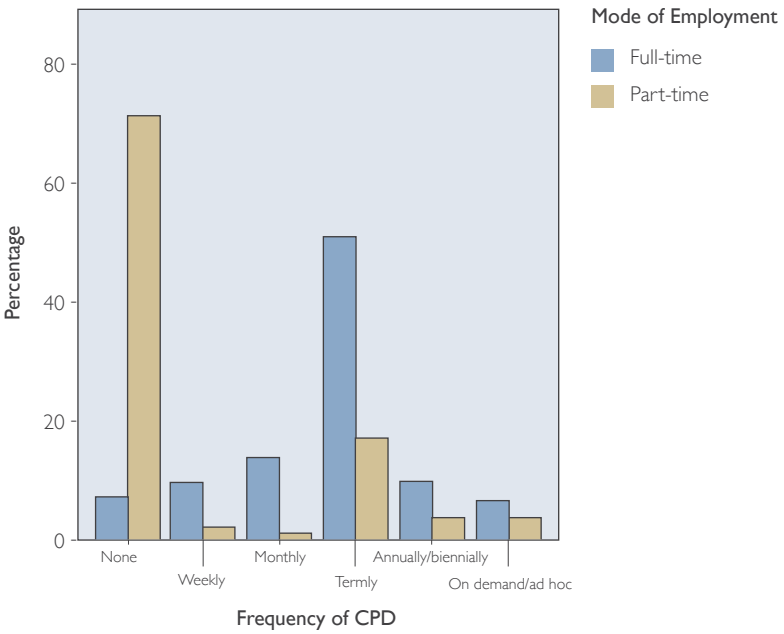


A possible explanation of fewer CPD opportunities in FE compared with sixth-form colleges is the greater proportion of part-time staff in FE colleges. This is borne out by inspection of Figure 18: part-time staff are 46 times less likely to receive regular CPD than their full-time colleagues. There may be a number of reasons for this, but the most likely is that such CPD activity takes place outside of their contracted hours and they are therefore not expected or required to attend. However, given that those currently learning on GCSE programmes and especially on numeracy and functional skills programmes are the most likely to be taught by part-time staff, particularly in FE colleges, then these are the individuals most in need of the CPD required to meet the government's policy ambitions. Thus investment over and above the cost of courses will be required to recompense part-time staff for attendance at CPD training.

41 See for example, the Department of Business, Innovation and Skills FE workforce development strategy: www.gov.uk/government/uploads/system/uploads/attachment_data/file/326000/bis-14-679-further-education-workforce-strategy-the-government-strategy-support-workforce-excellence-in-further-education.pdf

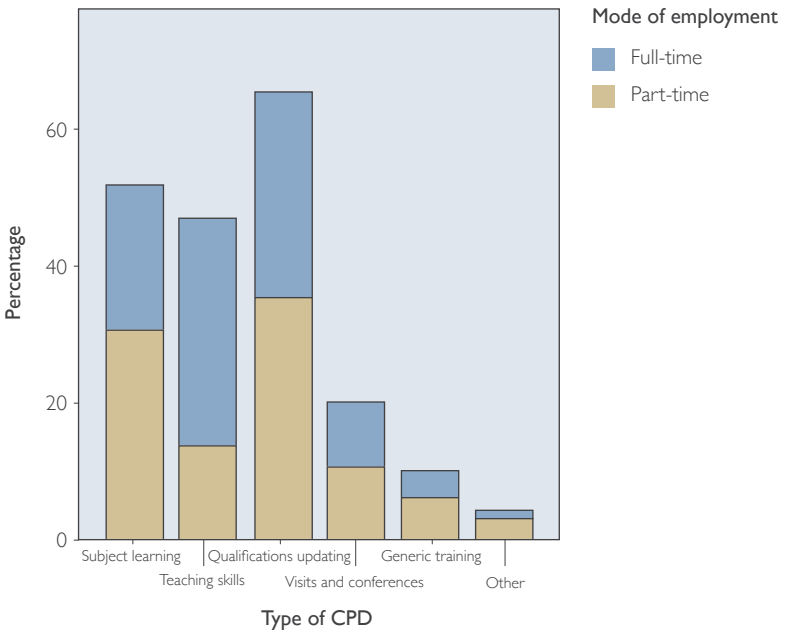
Given the level of upskilling required to meet the benchmark of a Level 5 qualification in mathematics, the cost of this activity, and the provision of cover (if that is possible) for full-time colleagues to attend mathematics enhancement activity, needs to be factored into the investment plans for the FE sector workforce development strategy.

Figure 18: Frequency of participation in CPD by mode of employment (n=77)



The range of CPD activities undertaken by participants, the range of outcomes, and its duration was extremely varied. Figure 19 uses a simple coding scheme to give some idea of the types of CPD activities currently being undertaken by both FE and sixth-form college mathematics teachers in the sample, disaggregated by their mode of employment. Overall the most common forms of CPD being undertaken by both full- and part-time teachers was qualification updating followed by subject learning. This indicates a willingness to update subject knowledge relevant to teaching new qualifications. Developing teaching skills was also a frequent type of activity for full-time staff, less so for those working part-time.

Figure 19: Proportion of different types of CPD activity being undertaken by mode of employment (n=77)



In response to questions about the types of CPD teachers had undertaken in relation to their main teaching subject, there were no statistically significant differences between sectors[42], mode of employment[43] and the subject areas taught[44]. In terms of the utility of the CPD they have received, it is difficult to draw conclusions as numbers responding are low. Suffice to say that part-time colleagues rated the CPD they received for teaching their main subject highly at 4.5 out of 5 (n = 8), as did those teaching numeracy and functional skills (4 out of 5).

Responses to the question about future CPD needs are very rich and diverse, but three types of CPD need relevant to implementing the post-16 mathematics policy are clearly identified in the comments. First, increasing subject knowledge: the earlier analysis indicates very strongly that many now teaching, say, functional numeracy, and who might well be asked to teach new mathematics qualifications in the future do not have GCE A-level or equivalent, let alone a Foundation or Honours degree in mathematics, or a in subject with a substantial mathematical content such as engineering or physics. Thus, there will be a strong need to upgrade mathematical content knowledge. This is reflected in some comments about future CPD needs:

'A Level 3 qualification in Maths'

'The opportunity to upgrade their own maths skills'

'A course that better prepares and equips Maths Tutors for delivering GCSE. Most are used to teaching functional skills but not GCSE.'

Second, many of the learners who will be expected to take mathematics qualifications in the future, even though it is clearly in their interests, may be

42 $\chi^2 = 8.7$, df = 6, $p>0.05$
43 $\chi^2 = 9.6$, df = 6, $p>0.05$
44 $\chi^2 = 20.2$, df = 12, $p>0.05$

reluctant to do so. There will therefore be the need for CPD that focuses on how to develop motivating teaching strategies, and making academic mathematics relevant to the lives of young people where the purpose of learning mathematics is not immediately apparent:

'Anything where new ideas about classroom delivery and teaching approaches are highlighted would be useful.'

'CPD to aid collaborative creation/ sharing of teaching resources in FE'

'How to build students' confidence in Maths'

'Trained to teach 11-16-year-olds but as is now teaching post-16 students, would welcome training on motivating those who've failed GCSE Maths in the past.'

'More/different teaching approaches and delivery methods training in order to vary style and keep students motivated.'

'Approaches to supporting weaker students; motivation and stimulation'

'Training on how to use real life examples and also equipment and resources that could be used to illustrate some of the theory being taught.'

'More support in relation to teaching the applications of maths – possibly going back to industry to keep up to date with changes in how maths can be/is used in a variety of industries – help to show students how further maths can be used in the real world.'

Finally there is always the need to keep abreast of qualification changes and assessment processes and procedures which is again reflected in comments about future CPD needs:

'Examination-based training to be more equipped to understand the examination criteria and marking.'

'Being kept up-to-date on curriculum and exam board changes.'

'Training to cover changes to exams/curriculum.'

The challenge in meeting these CPD requirements is making time for both full- and part-time staff, and that means paying part-time staff to attend courses and finding cover for full-time teachers.

SECTION 4 CONCLUSION

Government policy for raising mathematics attainment will require teaching demanding mathematics content to many more 16-18 year olds in the future. This in turn suggests a significant expansion demand for mathematics and numeracy teachers in sixth-form and particularly in FE colleges. To increase the capacity of the college workforce to deliver the proposed reforms will therefore require an increase in the recruitment of suitably qualified graduates. Expanding this supply pipeline significantly, even given the welcome introduction of bursaries for mathematics teachers in the college sector, is unlikely given the range of job opportunities open to mathematics, physics and engineering graduates, and the competition from schools for these valuable assets. Possibly more could be done to attract mathematics, engineering and science graduates later in their careers into teaching mathematics, recruiting from the armed forces for example, or to attract back to teaching mathematics teachers who have had a career break. But simply meeting replacement demand is likely to use this slightly increased supply. Thus, either FE colleges will need to find a new supply of those with an appropriate level of prior qualification needed to teach mathematics and numeracy programmes post-16, or they will have to develop such knowledge skills in new recruits and existing staff drawn from other discipline areas.

The GCSE, numeracy and functional skills programmes taught in FE colleges are far more likely than sixth-form colleges to be taught by a part-time workforce with much lower levels of academic preparation in mathematics, though often with high quality teaching qualifications. However, to meet the expansion demand of the policy for mathematics teachers, it is likely that greater emphasis will have to be placed upon using just such teachers who do not have a degree in mathematics or a related discipline, and often have a mathematics qualification no higher than GCSE Grade A*-C , to teach mathematics up to GCSE level. But the mathematics they would be expected to teach on the new GCSE programmes, and arguably stepping stone qualifications towards the GCSE, would be much more demanding in content than the current numeracy and functional skills qualifications. This suggests a need for considerable upskilling of the part-time, non-specialist component of the mathematics teaching workforce if the quality of mathematics teaching needed to deliver the government's policy aspiration is to be achieved.

Two areas therefore merit further and immediate attention to support this effort. First, FE colleges already teach mathematics and numeracy to a diverse array of learners, using a diverse array of teachers. Such teachers are typically well-qualified in terms of teaching qualifications but have a diverse academic background. Further, the teaching of GCSE and numeracy programmes in FE colleges is much more likely to be undertaken by a part-time workforce with a degree in a non-mathematical subject area, the very segment of the workforce that will need to be expanded and upskilled to deliver the new mathematics policy. Much could be learnt about the challenges of implementing the policy by a detailed examination of the work of these teachers and the CPD that they currently undertake and feel that they require in the future to deliver the new mathematics qualifications.

Second, an understanding is needed of how colleges will be enabled to release or pay for staff to attend the CPD they need to update subject content knowledge and skills, to develop new approaches to teaching and learning, and to understand what is required of learners in relation to new, more demanding assessments. This is a key question. The sums involved are likely to dwarf the current £15-20 million being provided for bursaries and incentives to attract mathematics teachers into the sector. Given the assumed economic benefits of a more mathematically literate population, the investment needed may well be justified, but the costs and benefits need to be quantified.

APPENDIX 1 MATHEMATICS POLICY POST-16

'A firm foundation in English and maths is essential to enable people of all ages to enjoy good employment prospects and social engagement. Employers value these skills above many others so it is critical that the qualifications in this area provide a robust assessment of an individual's knowledge and capabilities and are clearly recognised as doing so'.[45]

Following publication of the Wolf report[46] on vocational education and training, the government has adopted one of its main recommendations – to improve learners' attainment in mathematics – as government policy. The direction of travel is clear: continuing study of mathematics post-16 to achieve a good GCSE pass (A*-C); CPD for existing teachers; bursaries to encourage new mathematics teachers into the profession; forthcoming core mathematics specifications; and stepping stone qualifications to enable adult learners to progress to GCSE standard.

'A priority for action is to identify those qualifications in maths which best enable adult learners to progress to GCSE standard. The ambition is that once new GCSEs are available they will replace other qualifications as the single gold-standard for literacy and numeracy at level 2.'[47]

Central to this robustness is the idea that a new, more demanding GCSE in mathematics should act as the benchmark for what is required in terms of attainment for progression into the labour market.

'English and maths GCSEs are being reformed, and the new specifications will be taught for the first time in September 2015. They will be rigorous qualifications, capable of being achieved by the vast majority of students when teaching is good quality and adapted to different learning styles and circumstances. They will provide a strong foundation for progression to further academic and vocational study, and will include assessment of skills such as spelling, grammar and problem solving, so that employers can be confident that people with these GCSEs have demonstrated important skills that will be of value in the workplace.'[48]

The government published revised subject content for GCSE mathematics in November 2013[49]. Alongside this, government undertook a consultation on draft programmes of study for Key Stage 4 mathematics from December 2013–February 2014. A final version of this programme of study was published in July 2014[50]. Government policy following the consultation remains to develop a much more demanding mathematics GCSE qualification, and the policy intention is that this will also emerge as the predominant Level 2 qualification for the vocational and adult education sectors. The content includes working mathematically to develop fluency, reasoning mathematically, and solving problems through topics such as number, algebra, ratio, proportion and rates of change, geometry and measures, probability and statistics.

45 www.gov.uk/government/uploads/system/uploads/attachment_data/file/286749/bis-14-577-vocational-qualification-reform-plan.pdf

46 www.gov.uk/government/publications/review-of-vocational-education-the-wolf-report

47 ibid

48 ibid

49 www.gov.uk/government/uploads/system/uploads/attachment_data/file/254441/GCSE_mathematics_subject_content_and_assessment_objectives.pdf

50 www.gov.uk/government/uploads/system/uploads/attachment_data/file/331882/KS4_maths_PoS_FINAL_170714.pdf

'Our ambition is that once the new GCSEs are available they will replace other qualifications as the single gold-standard measuring achievement at Level 2 for all ages and ability levels. We will review assessment requirements for Level 2 and for progression towards that standard over the spring, summer and autumn of 2014.'[51]

The agenda being set out is aspirational, linked to robust evidence about the economic and personal benefits of improving the general level of mathematical capability in the population. However, the agenda is likely to be challenging to implement, as recognised by the Department for Business Innovation and Skills' *Further Education Workforce Strategy: The Government's Strategy to Support Workforce Excellence in Further Education*. In particular the strategy document pinpoints weak mathematics teaching in FE colleges, as reported by Ofsted[52], as a cause for concern, attributing this in part to:

'Too many teachers do not have the level of professional skills or subject knowledge needed in the key areas of maths and English, or the confidence and ability and capability to secure good outcomes for students with SEN … Foundation maths was one of the weakest subjects in FE colleges.'[53]

It is also clear that there is an appreciation that delivering these arrangements will be very challenging, not least in ensuring that there is adequate capacity in terms of the teaching workforce to deliver the new qualification. Steps are being taken to meet the challenge:

'Successful delivery of the new GCSEs is highly dependent on the quality of our teachers. We recognised the importance of improving the quantity and quality of the FE teaching workforce and agreed ambitious targets in May 2013. These were backed by an investment of £15 million for bursary payments in 2013-14 and 2014-15, and a further £20m for provider grants and teacher incentives, to support the recruitment of the best graduates to train as FE maths and English teachers, and to support those with Special Educational Needs. Through the Education and Training Foundation, we are also developing and delivering new programmes to improve links between teachers and employers; and to enhance the skills of existing maths and English teachers. These programmes will enable them to develop their skills to meet the demands of teaching maths and English up to Level 3.'

The issue is whether such inducements will be sufficient to meet the requirement of what is a mandated policy: to teach all young people aged 16-19 without GCSE A*-C the new GCSE syllabus. In December 2013, the government announced that funding for 18-year-olds in sixth-form and FE colleges would be reduced by 17.5% from September 2014[54]. Clearly a debate is needed across the sector on the best way to meet the challenges being posed by the Government for replacing, expanding and upskilling the college mathematics teaching force to deliver the new GCSE requirement. This report seeks to make a contribution to this debate by focussing on the current qualifications, modes of working and CPD of teachers delivering mathematics and numeracy in the English college sector (both FE and sixth-form colleges).

51 www.gov.uk/government/uploads/system/uploads/attachment_data/file/286749/bis-14-577-vocational-qualification-reform-plan.pdf

52 www.oftsed.gov.uk/resources/ofsted-annual-report-201213-further-education-and-skills

53 Department of Business Innovation & Skills (2014) Further Education Workforce Strategy: *The Government's Strategy to Support Workforce Excellence in Further Education*, p.8

54 www.gov.uk/government/uploads/system/uploads/attachment_data/file/264707/Peter_Mucklow_Letter_to_sector_ December_13.pdf

APPENDIX 2 EXTERNAL VALIDITY OF THE FACE-TO-FACE SURVEY

A few indicators can be used to assess the representativeness of the face-to-face survey conducted for this report by comparison with the SIR. In the sample the gender ratio amongst mathematics and numeracy teachers was 52% female to 48% male. The analysis of the SIR suggests that the overall gender ratio for science and mathematics teachers derived from the 2011-12 SIR is 55% female to 45% male. The gender ratios in the survey undertaken for this report and the SIR are reasonably similar.

In the sample generated for this report, 62.2% of mathematics teachers in FE colleges were employed on part-time contracts whereas the proportion given for science and mathematics teachers in the SIR is 53% on part-time contracts. Furthermore, in the aggregate data collected from FE colleges in this study the proportion of mathematics teachers working part-time was estimated to be less than 50%. Thus it would appear that part-time staff have been over-sampled in the survey undertaken for this study. However, this booster sample of part-time staff enables us to understand in greater detail this component of the mathematics and numeracy workforce in FE colleges who will be key in delivering the new post-16 GCSE mathematics curriculum.

The average age of FE college mathematics teachers in the current sample is 46.2 years, corresponding to that derived from the SIR (46 years, for science and mathematics teachers). Median contract duration for science and mathematics teachers in the SIR is 5.25 years, in this sample it is 8.4 years. Thus there is not an exact match between the composition of this sample and the data derived for the aggregate category of science and mathematics teachers in the SIR; caution needs to be exercised in drawing generalisations from the current study but the same applies to analyses derived from the SIR and the other surveys providing insights into the composition and qualification of the FE maths workforce.

APPENDIX 3 RESEARCH INSTRUMENTS

FE COLLEGE/SIXTH-FORM COLLEGE STEM SURVEY

A College type

FE College		SFC	

Reference Number	

B Name of college

1 Job title

Senior Lecturer	
Lecturer	
Teacher	
Tutor	
Instructor	
Other, please state:	

2 Basis of work (self-assessed)

Full-time	
Part-time	
Agency	

2.1 If part-time/agency what are your total contracted hours per week (on average)?
NUMERIC RANGE 1 … 30

2.2 What is the number of classroom contact hours per week (including form/tutor time)?
NUMERIC RANGE 1 … 35

2.3 If not teaching this year, in which academic year did you last teach?

2.4 How long have you been teaching?

2.5 How long have you worked at this college?

3.1 What qualifications (academic, vocational and professional) do you have (apart from teaching qualifications)?

HE	Subject (eg electrical engineering)
Doctorate	
Masters	
Honours degree	
Ordinary degree	
Foundation Degree	
HND	
HNC	
Diploma	
Certificate	
City & Guilds	
NVQ/SVQ	
Other	
Professional	**Subject**
Accounting	
Law	
Medicine	
Other	
Level 3	**Subject(s)**
A-level	
IB	
BTEC or OCR National Certificate/ Diploma	
Advanced GNVQ	
ONC/OND	
City & Guilds	
Welsh Baccalaureate	
Scottish Advanced Higher	
Scottish Higher	
NVQ/SVQ	
Advanced Apprenticeship	
Other	

Level 2	Subject (where appropriate, not for GCSE/O-level)
GCSE (A*-C) total number	
O levels	
GCSE/O-level (A*-C) Maths (Y/N)	
CSE Grade 1	
GNVQ Intermediate	
BTEC or OCR First Certificate/Diploma	
Welsh Baccalaureate	
Scottish Standard Grade (1-3) or Ordinary (A-C)	
NVQ/SVQ	
Intermediate Apprenticeship	
Other	

3.2 What is your highest (non-teaching) maths qualification? [Self-assessed]

HE	Description or Subject	Grade
Doctorate		
Masters		
Honours degree		
Ordinary degree		
Foundation Degree		
Diploma		
Certificate		
Other		
Level 3		
A-level		
IB		
Welsh Baccalaureate		
Scottish Advanced Higher		
Scottish Higher		
Other		
Level 2		
GCSE (A*-C)		
O-level		
CSE Grade 1		
Welsh Baccalaureate		
Scottish Standard Grade (1-3) or Ordinary (A-C)		
Other		

4 Do you have, or are you working towards, a teaching qualification, and, where applicable, through which route did you obtain it?

	Teaching qualification	Achieved	Working towards	Subject specialism
1	PGCE a) HEI			
	b) Teach First			
	c) School Direct			
	d) SCITT PGCE			
	e) SCITT GTP			
2	CertEd			
3	Preparing to teach in the lifelong learning sector (PTLLS)			
4	Certificate in teaching in the lifelong learning sector (CTLLS)			
5	Diploma in teaching in the lifelong learning sector (DTLLS)			
6	Post-Compulsory Education and Training (PCET)			
7	FE Teaching Certificate (FETC) Stage 1 or Further Adult Education Teaching Certificate (FAETC)			
8	FETC Stage 2 or FAETC			
9	FETC Stage 3 or FAETC			
10	BTEC Level 3 Certificate in Teaching in the Lifelong Learning Sector			
11	City & Guilds Further Education Teaching Level 4			
12	City & Guilds Further Education Teaching Level 5			
13	Level 3 Award in Education & Training			
14	Level 4 Certificate in Education & Training			
15	Level 5 Diploma in Education & Training			
16	Level 5 Diploma in Education & Training with specialist pathway			
17	BEd			
18	QTS a) SCITT QTS			
	b) SCITT GTP			
	c) School Direct			
	d) Teach First			
	e) Other			
19	Skills for Life Qualifications: a) literacy			
	b) numeracy			
	c) ESOL			
20	Other, eg TEFL, Music Teaching Diploma, Assessor A/D Units – please state:			

5 Thinking of your last full week of teaching, what are the main courses/ programmes you teach on and at what level, up to Level 4? [top 3 if many]

Level	First	Second	Third
Description			
L 1			
L 2			
L 3			
L 4			

Note: For maths teachers, GCSE, A-level Maths, A-level Further Maths count as separate programmes. If A-level Further Maths, check modules as separate courses and note.

5.1 Does your college have regular general CPD/training sessions?

No		
Yes	Weekly	
Yes	Monthly	
Yes	Termly	
Yes	Other_____	

Thinking of the programme/course you teach the <u>most</u>

6.1 How many hours is that per week?

6.2 What (non-teaching) qualification do you have that is most relevant to teaching this programme/course?

HE	Subject (eg electrical engineering)
Doctorate	
Masters	
Honours degree	
Ordinary degree	
Foundation Degree	
HND	
HNC	
Diploma	
Certificate	
City & Guilds	
NVQ/SVQ	
Other	

Professional	Subject
Accounting	
Law	
Medicine	
Other	
Level 3	**Subject(s)**
A-level	
IB	
BTEC or OCR National Certificate/Diploma	
Advanced GNVQ	
ONC/OND	
City & Guilds	
Welsh Baccalaureate	
Scottish Advanced Higher	
Scottish Higher	
NVQ/SVQ	
Advanced Apprenticeship	
Other	
Level 2	**Subject (where appropriate, not for GCSE/O-level)**
GCSE (A*–C) total number	
GCSE (A*–C) Maths	
O-level	
CSE Grade 1	
GNVQ Intermediate	
BTEC or OCR First Certificate/Diploma	
Welsh Baccalaureate	
Scottish Standard Grade (1–3) or Ordinary (A–C)	
NVQ/SVQ	
Intermediate Apprenticeship	
Other	

6.3 Have you undertaken any training or CPD to support your teaching of this programme/course?

Yes	
No	

If No, Go to Question 6.5

6.4 Briefly describe three CPD examples, relevant to your teaching of this subject, over the past 3 years

CPD1: recent
CPD2: most intensive/significant
CPD3: most valuable

6.4.1 If Yes, for approximately how long?
NUMERIC VALUE 0.5 day or less, 1 day…1 week…6 months+

CPD1	
CPD2	
CPD3	

6.4.2 How long ago?
NUMERIC RANGE Less than 1 month, 1 month, 2 months…10 years

CPD1	
CPD2	
CPD3	

6.4.3 How useful was this training or CPD to assist in your teaching of this programme/course?

	CPD1	CPD2	CPD3
5 (Very useful)			
4			
3			
2			
1 (Not very useful)			

6.5 What type(s) of CPD would you be interested in, to support your teaching of this programme/course?

6.6 Do you have any industrial/business experience relevant to teaching this programme/course?

Yes	
No	

Go to next subject or Question 9 if no more subjects

6.6.1 If Yes, please describe briefly

6.6.2 If Yes, how many years total experience?
NUMERIC RANGE Less than 1 year…20+ years

6.6.3 How long since you finished this experience?
NUMERIC RANGE Less than 1 year. … 10+ years

6.6.4 How valuable is this experience to your teaching of this programme/course?

	Value of experience
5 (Very valuable)	
4	
3	
2	
1 (Not very valuable)	

7.1 Thinking about the programme/course you teach the second-most, how many hours is that per week?

7.2 What (non-teaching) qualification do you have that is most relevant to teaching this programme/course?

HE	**Subject (eg electrical engineering)**
Doctorate	
Masters	
Honours degree	
Ordinary degree	
Foundation Degree	
HND	
HNC	
Diploma	
Certificate	
City & Guilds	
NVQ/SVQ	
Other	
Professional	**Subject**
Accounting	
Law	
Medicine	
Other	
Level 3	**Subject(s)**
A-level	
IB	
BTEC or OCR National Certificate/Diploma	
Advanced GNVQ	
ONC/OND	
City & Guilds	
Welsh Baccalaureate	
Scottish Advanced Higher	
Scottish Higher	
NVQ/SVQ	
Advanced Apprenticeship	
Other	

Level 2	**Subject** (where appropriate, not for GCSE/O-level)
GCSE (A*–C) total number	
GCSE (A*–C) Maths	
O-level	
CSE Grade 1	
GNVQ Intermediate	
BTEC or OCR First Certificate/Diploma	
Welsh Baccalaureate	
Scottish Standard Grade (1–3) or Ordinary (A–C)	
NVQ/SVQ	
Intermediate Apprenticeship	
Other	

7.3 Have you undertaken any training or CPD to support your teaching of this programme/course?

Yes	
No	

If No, Go to Question 7.5

7.4 Briefly describe three CPD examples, relevant to your teaching of this subject, over the past 3 years (recent, intensive/significant, useful)

CPD1: recent
CPD2: most intensive/significant
CPD3: most valuable

7.4.1 If Yes, for approximately how long?
NUMERIC VALUE 0.5 day or less, 1 day…1 week…6 months+

CPD1	
CPD2	
CPD3	

7.4.2 How long ago?
NUMERIC RANGE Less than 1 month, 1 month, 2 months…10 years

CPD1	
CPD2	
CPD3	

7.4.3 How useful was this training or CPD to assist in your teaching of this programme/course?

	CPD1	CPD2	CPD3
5 (Very useful)			
4			
3			
2			
1 (Not very useful)			

7.5 What CPD areas would you be interested in, relevant to teaching this programme/course?

7.6 Do you have any industrial/business experience relevant to teaching this programme/course?

Yes	
No	

Go to next subject or Question 9 if no more subjects

7.6.1 If Yes, please describe briefly?

7.6.2 If Yes, how many years total experience?
NUMERIC RANGE Less than 1 year…20+ years

7.6.3 How long since you finished this experience?
NUMERIC RANGE Less than 1 year…10+ years

7.6.4 How valuable is this experience to your teaching of this programme/course?

	Value of experience
5 (Very valuable)	
4	
3	
2	
1 (Not very valuable)	

8.1 Thinking about the programme/course you teach the third-most, how many hours is that per week?

8.2 What (non-teaching) qualification do you have that is most relevant to teaching this programme/course?

HE	**Subject (eg electrical engineering)**
Doctorate	
Masters	
Honours degree	
Ordinary degree	
Foundation Degree	
HND	
HNC	
Diploma	
Certificate	
City and Guilds	
NVQ/SVQ	
Other	
Professional	**Subject**
Accounting	
Law	
Medicine	
Other	
Level 3	**Subject(s)**
A-level	
IB	
BTEC or OCR National Certificate/Diploma	
Advanced GNVQ	
ONC/OND	
City & Guilds	
Welsh Baccalaureate	
Scottish Advanced Higher	
Scottish Higher	
NVQ/SVQ	
Advanced Apprenticeship	
Other	

Level 2	Subject (where appropriate, not for GCSE/O-Level)
GCSE (A*–C) total number	
GCSE (A*–C) Maths	
O-level	
CSE Grade 1	
GNVQ Intermediate	
BTEC or OCR First Certificate/Diploma	
Welsh Baccalaureate	
Scottish Standard Grade (1–3) or Ordinary (A–C)	
NVQ/SVQ	
Intermediate Apprenticeship	
Other	

8.3 Have you undertaken any training or CPD to support your teaching of this programme/course?

Yes	
No	

If No, Go to Question 8.5

8.4 Briefly, describe three CPD examples, relevant to your teaching of this subject, over the past 3 years

CPD1: recent
CPD2: most intensive/significant
CPD3: most valuable

8.4.1 If Yes, for approximately how long?
NUMERIC VALUE 0.5 day or less, 1 day…1 week…6 months+

CPD1	
CPD2	
CPD3	

8.4.2 How long ago?
NUMERIC RANGE Less than 1 month, 1 month, 2 months…10 years

CPD1	
CPD2	
CPD3	

8.4.3 How useful was this training or CPD to assist in your teaching of this programme/course?

	CPD1	CPD2	CPD3
5 (Very useful)			
4			
3			
2			
1 (Not very useful)			

8.5 What CPD areas would you be interested in relevant to teaching this programme/course?

8.6 Do you have any industrial/business experience relevant to teaching this programme/course?

Yes	
No	

Go to Question 9

8.6.1 If Yes, please describe briefly

8.6.2 If Yes, how many years total experience?
NUMERIC RANGE Less than 1 year…20+ years

8.6.3 How long since you finished this experience?
NUMERIC RANGE Less than 1 year…10+ years

8.6.4 How valuable is this experience to your teaching of this programme/course?

	Value of experience
5 (Very valuable)	
4	
3	
2	
1 (Not very valuable)	

[IF MATHS TEACHER, SKIP TO QUESTION 9.3, OVER PAGE]

[NON-MATHS TEACHER]

9 Do you teach any Maths/Numeracy on any of your programmes/courses?

Yes	
No	

9.1 If Yes, how many hours does this involve?

	Hours per week
Teaching full subject qualification	
Functional Skills/Essential Skills/Skills for Life in Numeracy	
Mathematical component in Programme/Course	
Other, please state:	

9.2 Have you undertaken any training or CPD to support your teaching of Maths?

Yes	
No	

9.2.1 If Yes, for approximately how long?

NUMERIC VALUE 0.5 day or less, 1 day…1 week…6 months+

9.2.2 How long ago?

NUMERIC RANGE Less than 1 month, 1 month, 2 months…10 years

9.2.3 Briefly, describe this training or CPD

NB Do not ask for information on Maths training or CPD if already collected above.

[MATHS TEACHER]

9.3 Do you teach maths on any other course or programme?

Yes	
No	

If yes please describe:

[ALL STAFF]

10 Do you perform a significant role other than teaching? [self-defined]

Yes	
No	

10.1 Please describe briefly, in what areas? [self-defined]

Management	
Administration	
Other, please state:	

11 Sex of respondent

Male		Female	

12 Age last birthday
NUMERIC RANGE 14…95

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