

Beginning teaching: best in class?

High-quality initial teacher education for all
teachers of mathematics in England

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1 Chair's foreword: Professor Philip England FRS



Two major issues in education are the quantity and quality of teachers of mathematics. In this report, ACME considers the quality of initial teacher education and gives advice on how to ensure that trainees leave initial teacher education (ITE) effectively equipped to begin their teaching careers in mathematics classrooms throughout England.

There is agreement that improving the mathematical skills of young people in England is essential. Recent reforms mean that there are promising signs that more young people will have the opportunity to develop mathematical skills that will serve them well as they move to employment or further and higher education. If these reforms are to be realised, high-quality teachers of mathematicsⁱ are needed in classrooms throughout England.

So what mathematics-specific knowledge do traineesⁱⁱ need to gain during ITE to become high-quality teachers of mathematics? What structures need to be in place for trainees?

It has been well documented that routes into teaching are very complex and include school-led, university-led and employment-based approaches (see Box 2). Trainees have very different experiences depending on the routes they choose. The Carter Review of Initial Teacher Training (ITT)ⁱⁱⁱ (see Box 4)¹ concluded that debates about

where ITE is completed were not 'terribly helpful' and noted the need for partnership between schools and universities. Whatever route is taken, **ACME argues that there are a number of elements that should be consistent across every ITE programme.**

To get and keep high-quality teachers of mathematics in the primary and secondary classroom and in colleges, it is imperative that all of those involved in ITE and those supporting newly qualified teachers have a shared understanding of what constitutes high-quality teacher education for teachers of mathematics. In Ofsted's 2013 – 2014 annual report, it was stated that '94% of active teacher training partnerships were judged good or outstanding'.² The implication is that the vast majority of ITE is good. Does this mean that teachers are being educated to the level that will improve the quality of mathematics education? Will this understanding of 'good' by Ofsted be good enough to meet the challenge of England becoming a world-class mathematics education system?

Box 1: ACME's aspiration for ITE for teachers of mathematics

ITE is the first stage in a teacher's professional journey. On leaving ITE new teachers of mathematics should:

- have firm foundations in subject knowledge and have gained deep pedagogical subject knowledge;
- be equipped with the skills and knowledge to engage with critical evaluation;
- have been mentored for a year and have two years mentoring ahead of them;
- understand the importance of subject-specific professional development throughout their career and be supported for two further years to embed their learning.

i. Teachers of mathematics encompasses all those who teach mathematics through all phases of education, including at primary level.

ii. When referring to those in ITE, ACME utilises the term 'trainees', in accordance with current usage.

iii. In this report ACME refers to Initial Teacher Education (ITE). Others utilise the term Initial Teacher Training (ITT). The latter is therefore used when referring to some policy reports and in some quotations.

As is set out in more detail in the report, ACME believes that good ITE offers trainees the opportunity to develop deep pedagogical knowledge of mathematics. Good ITE also ensures that trainees have the opportunity to gain and develop critical evaluation skills. ACME argues that every trainee should be in a structured mentoring programme with, or with access to, mathematics specialist teachers. Finally, the link between ITE and early professional development is key to developing high-quality teachers of mathematics and the report highlights the importance of trainees gaining an understanding of the entitlement and responsibility they have to undertake mathematics-specific professional development through their teaching life.

The principles that ACME sets out are a call for action for ITE providers, senior leaders, trainees, early career teachers and the mathematics community. Some of the principles and recommendations may seem challenging and will require buy-in and investment from a range of individuals and organisations. **However, if the community is committed to the shared goal of producing and retaining the best teachers of mathematics, then a step change is required. (See Table 1.)**

What was clear during the year spent undertaking the research and stakeholder engagement for this report was that there are very strong links between the supply of teachers and the ITE they receive. There have been several positive governmental initiatives and incentives to encourage more teachers into training and to upskill those already in the classroom. However, it was often highlighted during stakeholder engagement that England faces a great challenge in getting more teachers into classrooms and keeping them there. It was also evident there is not a clear picture of the size of the issues faced since data on the recruitment and retention of teachers of mathematics is insufficient. Much more thinking is still required about issues such as accountability for recruitment, regional and national infrastructures and the accreditation of various programmes and initiatives. All of these aspects, and others, should be looked at together as part of an action plan on the initial teacher education for teachers of mathematics. This will need much more work and will require collaboration and buy-in from governmental and non-governmental actors. **The report concludes with some recommendations on the essential first steps in establishing a long-term strategic plan for ITE of teachers of mathematics.**

Figure 1: Key stages during and after ITE

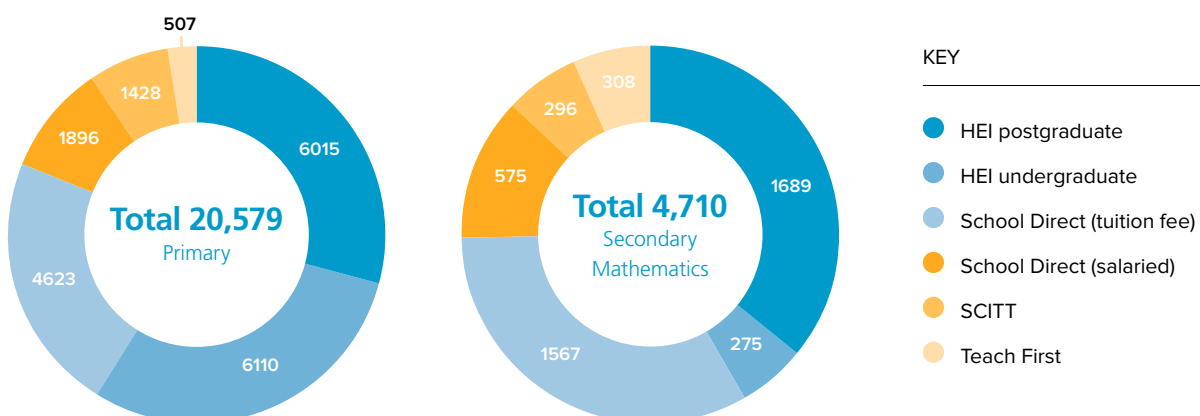
Entrant to ITE	Trainee	Teacher with qualified teacher status	Newly qualified teacher (NQT)	Early career teacher
Someone accepted onto an ITE programme. ITE entry may be dependent on minimum requirements and also the completion of a Subject Knowledge Enhancement (SKE) course.	Someone who is on an undergraduate or postgraduate ITE course in school-based and university-based settings. The term student teacher is also in common usage.	By the end of ITE, trainees need to meet all the Department for Education standards for Qualified Teacher Status (QTS), including those that relate to subject and curriculum knowledge. ³	Someone who has been qualified as a teacher for less than 12 months.	In this report, the term early career teacher is used to describe teachers during their first three years of teaching.



Box 2: Some routes into ITE

Higher education institution (HEI)	<ul style="list-style-type: none"> • HEIs offer the majority of ITE courses. • A Postgraduate Certificate in Education (PGCE) course allows those with an undergraduate degree to gain qualified teacher status (QTS). Training typically lasts one year when completed full-time. • HEIs also offer undergraduate routes leading to QTS.
School-centred ITT (SCITT)	<ul style="list-style-type: none"> • Schools approved to deliver initial teacher training directly themselves are called school-centred initial teacher training (SCITT) providers. • SCITT training generally last a year and training is given by teachers at the school in which trainees are based. • Training can lead to the award of a PGCE from a university.
School Direct (fee)	<ul style="list-style-type: none"> • School Direct is the main school-led training route. • It is delivered by a partnership of a school or schools, and an accredited teacher training provider – a university or a school approved to carry out SCITT. • Trainees are recruited by School Direct schools, and given on-the-job training generally lasting a year.
School Direct (salaried)	<ul style="list-style-type: none"> • The salaried School Direct option is aimed at those with three years' experience of working elsewhere before starting training. • Trainees on this route are paid a salary by the school. • Trainees are recruited by School Direct schools, and given on-the-job training generally lasting a year.
Other routes	<ul style="list-style-type: none"> • <i>TeachFirst</i> is a government-funded but independently run organisation that puts high-achieving graduates and those changing careers into low-income communities. • A condensed period of teacher training is provided. <i>Teach First</i> participants begin teaching after concluding a 6 week National Programme offered across ten universities (4 weeks in the local area, 2 weeks centrally). This is built on throughout the year, both in practice- and university-based settings. There are six subject-specific days in a university during the first year of teaching.

Figure 2: ITE allocations 2015 – 16⁴



2 Introduction: Why undertake a study on the

ITE of teachers of mathematics?

In 2013 ACME set out its vision for professional development in a policy report, *Empowering teachers: success for learners*.⁵

ACME noted the importance of empowering all teachers of mathematics through having a culture of professional development. In that report some of the challenges in ITE were noted. ACME wrote that ‘mathematics teaching quality is critically important, yet teachers in England often have lower qualifications in mathematics and receive less initial training than their international counterparts. Many [primary] teachers have the minimum qualification in mathematics (GCSE Mathematics Grade C) and many secondary schools struggle to appoint teachers with appropriate qualifications and expertise, although the full extent of this problem is not known’.

In addition to these challenges, ACME also recognises:

- the difficulties in recruiting and retaining teachers of mathematics;⁶
- that trainees taking different ITE routes gain very varied experiences (see Box 2 and Figure 3) and not all training places allocated to ITE providers are filled (see Figure 3);
- that recent reforms to mathematics curricula and the aims to increase the mathematical skills of all young people (see Box 5) will not be successful without enough competent and confident teachers of mathematics.

There is, therefore, an urgency to consider what ITE for teachers of mathematics should look like and to articulate a shared standard for ITE.

The analysis for this report included:^{iv}

- research on English and international practice and policy;⁷
- case studies on 8 ITE providers in England;⁸

- a survey asking the community for views on some of key elements needed for good ITE provision for teachers of mathematics in England;⁹
- a roundtable held in March 2015 with key stakeholders from the mathematics and wider education community.

Stakeholders reiterated the urgent issues with the supply of secondary mathematics teachers and a lack of access to primary mathematics specialists with master’s level qualifications. Although this report focuses on the ITE of teachers of mathematics in England, ACME recognises that raising the quality of initial teacher education is likely to improve the supply of teachers. Therefore, **Section B indicates where further analysis and research is needed and identifies some of the elements that could form part of a comprehensive plan to secure the future supply and ITE of high-quality teachers of mathematics.**^v

“No matter how well organised or detailed the curriculum, how grand or well resourced the building, what really matters most in a child’s education is the quality of the teaching. The challenge for the nation is to maintain a supply of outstanding teachers so that every child has the opportunity to be taught by inspirational, skilled teachers throughout their time in school.”

Carter Review of ITT

iv. Methodology available at www.acme-uk.org.

v. ACME’s observations are limited to mathematics in the main, but some observations may also be relevant for STEM (Science, Technology, Engineering and Mathematics).

Box 3: The Carter review of initial teacher training

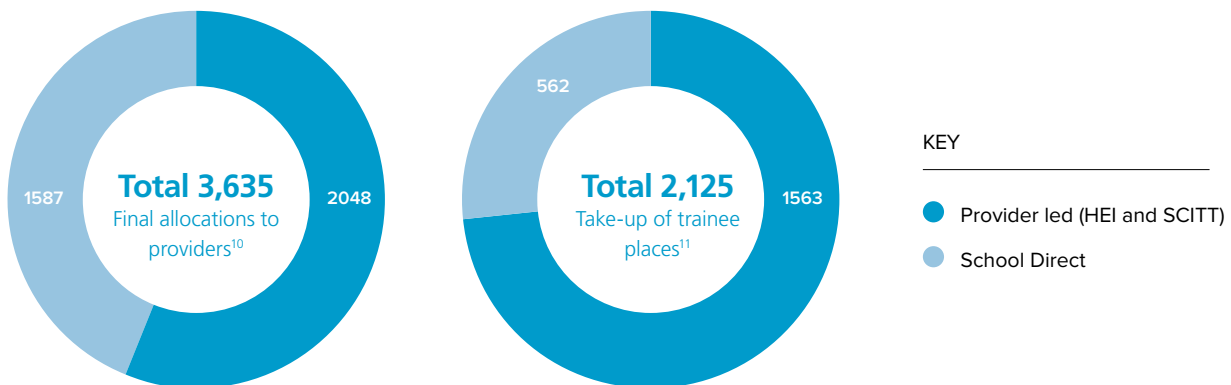
In April 2014, Sir Andrew Carter was asked by the Secretary of State for Education to undertake a review of the ITE system. The review was published in January 2015.

The Review stated that the system 'generally performs well, with some room for improvement in particular areas' and suggested 'it is difficult to draw conclusions about whether one route into teaching is any more effective than another. We have found strengths across all routes'.

The Review is detailed in nature. Some main messages from the Review:

- The most effective courses address gaps and misconceptions in trainees' core subject knowledge.
- Across all subjects and phases there is variability in the way subject knowledge is addressed.
- ITE should address subject-specific issues including phases of progression within the subject, links between subjects as well as common misconceptions and how to address these.
- There is a need to develop a framework of core content for ITE.
- Evidence-based teaching should be part of a framework for ITE.
- ITE partnerships should ensure all trainees experience effective mentoring.
- ITE is initial; the best providers and schools develop programmes for trainees that will equip them well to start out as effective teachers, forming the basis for on-going development.

Figure 3: Secondary mathematics ITE 2014 – 15



3 Section A: What makes for effective ITE of teachers of mathematics?

The 2015 Carter Review of ITT (hereafter the Carter Review), is referenced throughout this report (see Box 4). In the Carter Review, subject-specific education and support received during ITE was noted as central to good ITE.¹² The Carter Review was tasked with looking at ITE for all subjects.

Here, ACME takes a closer look at the mathematics-specific aspects that are needed to educate teachers of mathematics, including mathematics subject knowledge and deep pedagogical subject knowledge. ACME defines ‘pedagogical subject knowledge’ as the in-depth understanding of the mathematics content to be taught and the relevant teaching approaches. Subject knowledge on its own is not sufficient.¹³

ACME also draws attention to the importance of ITE equipping new teachers with critical evaluation skills, embedding an understanding of the importance of professional development and providing mentor support. These elements are also looked at through a mathematical lens. These elements are set out in Table 1 and in more detail below.

Table 1: Some key elements for the effective ITE of teachers of mathematics

Entry qualifications	Primary Entrants to ITE should have at least a Grade C (Grade 5) in GCSE Mathematics or equivalent. In the long term, entrants should have a qualification in mathematics at Level 3.
	Secondary Entrants to ITE should have a firm foundation in mathematics subject knowledge, either gained from degree-related study or from a regulated subject knowledge enhancement (SKE) course.
Mathematics-specific education	Primary ITE should enable trainees to develop in-depth pedagogical subject knowledge in mathematics.
	Secondary ITE should enable trainees to build on their mathematics and develop deep pedagogical subject knowledge.
Critical evaluation skills	Trainees should become research literate: they need to develop critical evaluation skills, which can involve evaluation of research, analytical reflection, enquiry skills, lesson study and action research. These skills should allow teachers to explore their own practice and that of others.
Mentoring	Primary Trainees should be in a structured mentoring programme with a school-based trained mentor who recognises when trainees require mathematics-specialist support and knows how to access this.
	Secondary Trainees should be in a structured mentoring programme with a school-based trained mathematics specialist mentor.
	Mentoring should continue during the Newly Qualified Teacher (NQT) year and the following year.
Linking ITE and early stage professional development	ITE and early stage professional development should be more closely aligned and there should be clear stages for progression. A structured three year professional development programme is required, which runs during ITE and continues two years after ITE. There should be clear roles and responsibilities for those providing and supporting ITE and for trainees.



Box 4: Primary mathematics

- About one quarter of the approximately 20,000 primary trainees follow a Bachelor of Education/ Bachelor of Arts (with QTS) route.
- About three quarters are in postgraduate ITE (usually a one year course).
- Out of a total of 19,820 primary trainees in 2013 – 14, the National College for Teaching and Learning (NCTL) recorded 80 primary mathematics specialists.¹⁴ 188 places were allocated for 2015 – 16 (see Figure 2).
- Bursaries to train as a primary mathematics specialist are available. Those with a B (or above) in A level Mathematics and a 2:2 degree (or above) can get £6000, while those with lower than a 2:2 degree can get £3000.
- Some primary ITE courses offer an optional specialism, including mathematics, at both undergraduate and graduate levels. Exact numbers are not currently available. However, allocations for 2015 – 16 suggest there will be 513 places to take the “Primary – general (with mathematics)” route (out of the 16,500 “Primary – general” places allocated).
- Primary mathematics specialism” may also be obtained after QTS, e.g. master’s level study.

4 Some key elements for the effective ITE of teachers of mathematics

What mathematical understanding should entrants to ITE have?

Where are we now?

Entry qualifications – Primary

- Most entrants to primary ITE will not have not studied mathematics from the age of 16 onwards.
- The minimum requirement for entry to primary ITE is a grade C in GCSE Mathematics and passing a numeracy test. This is a very low threshold given that every primary teacher is a teacher of mathematics.

Currently, ITE providers require their entrants to have a Grade C in GCSE Mathematics and to have passed a numeracy test. In many jurisdictions, including all those reviewed by ACME, entrants to primary ITE have taken mathematics qualifications at a higher level than in England.^{15,16}

In the short term, it seems likely that GCSE Mathematics will remain the requirement for entry (Grade C until 2017, thereafter Grade 5). Even though the new GCSE Mathematics is a larger and potentially more demanding qualification, Grade 5 in GCSE Mathematics is arguably a relatively low threshold for entry. ACME would prefer to see the requirement for mathematics qualifications increased over time. This is needed if England is to compete with other countries.

A new post-16 Level 3 qualification, Core Maths, was introduced in 2015. This may, in time, lead to more people taking mathematics post-16. In the long term, all learners should take some mathematics post-16, for example Core Maths.¹⁷

In ACME's survey, there was a question about the level of qualification thought to be needed by entrants to primary ITE. Responses were varied, with suggestions ranging from continuing with the current requirement of Grade C in GCSE Mathematics to

raising the requirement to a Level 3 qualification, either AS or A level Mathematics or Core Maths (see below). However, many respondents qualified their responses by expressing a concern that raising the entry requirement would lead to potential problems for the recruitment of primary teachers.

In the Carter Review, it was noted that 'the breadth of the subject knowledge primary teachers need to teach the new curriculum, for example, may be difficult to cover, especially within a one year programme' and recommended a potential 'bridge to ITT' courses. Courses that provide a bridge to ITE might prove a useful interim measure before raising the entry requirement and might help to improve trainees' mathematical knowledge on entry.

Recommendations:

In the short term all entrants to primary ITE should have at least a Grade 5 in the reformed GCSE Mathematics or an equivalent Level 2 qualification.

In the long term there should be a move towards a system where everyone has a Level 3 mathematics qualification on entry. The overarching strategy for ITE would set out how to make this possible (see Figure 4).

Where are we now?

Entry qualifications – Secondary

- In postgraduate ITE, there is an expectation that subject knowledge is gained prior to ITE.
- In the past, most entrants to secondary mathematics ITE had a mathematics or related degree.
- Those with degrees that do not cover mathematics are often accepted onto ITE courses with the condition that a Subject Knowledge Enhancement (SKE) course is completed.
- SKE courses vary in length and in structure.

Unlike primary ITE, the vast majority of entrants to secondary ITE are on a postgraduate route.¹⁸ There is an expectation that subject knowledge should be gained prior to ITE.¹⁹ In the Department for Education's (DfE) ITE criteria there is no requirement for secondary trainee teachers to have a degree in a specified subject.²⁰ Indeed, the challenges with the recruitment of mathematics teachers (see Section B) mean that the need for mathematics teachers at secondary level will not be met by graduates of mathematics or related disciplines.²¹

Providers determine the entry requirements for those with both mathematics-related and non-mathematics degrees and/or will identify the need to undertake a subject knowledge enhancement (SKE) course (see Box 6).²² ITE providers now offer entry to a wide variety of applicants (see Case Studies 1 and 2). The Carter Review emphasised the importance of SKE courses in addressing gaps in trainees' core subject knowledge. The large majority of ACME's survey respondents also noted the importance of SKE courses in attracting non-mathematics graduates to mathematics teaching. However, a number of respondents to the survey voiced concerns about the 'variability in the content and pedagogy in these courses'²³ and highlighted the need for the comparability of content across SKE courses, and the introduction of regulation and accreditation of courses to ensure quality and comparability. The Association of Mathematics Education Teachers (AMET) highlighted changes in the funding, provision and organisation of SKE courses in recent years and argued this led to greater variation in provision of SKE courses.²⁴

Recommendations:

Entrants to secondary mathematics ITE should have undertaken a degree course with substantial mathematical elements or have completed a mathematics SKE course.

The content and delivery of SKE courses must be regulated and quality assured through accreditation.

For entrants without a degree covering substantial mathematical elements, SKE courses should have a minimum of 150 hours contact time.²⁵



Box 5: Overview of some mathematics qualifications in England

GCSE Mathematics (Level 2)	Core Maths (Level 3)	A level Mathematics (Level 3)
Grade C in GCSE Mathematics has been the requirement for entry to primary level ITE. A new GCSE Mathematics was introduced in September 2015, with first assessment in summer 2017. A 1 – 9 grading scale will be used. Grade 5 will be awarded to around the top third of learners gaining the equivalent of a grade C and bottom third of a grade B. This is likely to be the threshold for entry to ITE.	Core Maths is a new suite of qualifications available to all schools and colleges from September 2015. The qualifications aim to provide learners with at least a C at GCSE Mathematics the opportunity to study mathematics post-16. Approximately 250,000 learners could benefit from this qualification.	A level Mathematics is the most popular A level, making up over 10% of all A levels taken in 2015. A new A level Mathematics qualification is to be introduced in September 2017.

CASE STUDY 1

School 2 (secondary) – 12 School Direct trainees (3 secondary mathematics)

For entry to secondary ITE, the ideal for the school is a 2:1 degree or First in Mathematics. In addition, the trainee must 'show their enthusiasm and energy at interview', which is held with both the school and a local HEI. The applicant is also required to teach a class. The learners being taught also provide feedback to the school on the ITE applicant. It was noted that the school is looking for applicants who give 'that bit extra' and therefore would 'consider those with 2:2 qualification provided they did well in the interview process'. The school said that they would not rule out candidates from other disciplines, for example Engineering or Business, provided they did well at interview.

The school described the current mathematics department as successful and as having a significant number without mathematics backgrounds.

CASE STUDY 2

University C (secondary) – 20 PGCE in mathematics, 10 School Direct (fee) and 3 School Direct (salaried)

For entry to secondary ITE, the university requires a 2:2 degree minimum. However, like Case Study 1, it is noted that there is scope for flexibility 'in exceptional circumstances'. The university highlighted that they cannot 'relax the requirements on GCSE in English and Mathematics' (Grade C). The university noted that they will consider a range of degree subjects and may offer a place to a candidate with a good A level(s) in Mathematics or Further Mathematics who studied non-mathematical subjects at university. The university noted that they prefer applicants 'who have the right skills and mindset for teaching and teach them the mathematics, rather than mathematicians who don't know how to relate to people'. The university emphasised their 'pragmatic approach', noting that they offered a place to a graduate with a music degree, with the condition that they undertake a SKE course.

What mathematics-specific content do trainees require?

Where are we now?

Mathematics-specific education – Primary

- Most primary teachers are trained to teach all subjects.
- If on a one year ITE course, the mathematics-specific elements are typically equivalent to a few days.
- There is no agreed mathematics-specific content for primary ITE across providers.

Each primary trainee will have to cover a whole range of subjects. As primary teachers are also teachers of mathematics, by the end of ITE, primary trainees should have developed in-depth mathematics pedagogical subject knowledge. Primary trainees cover very different material content and have different experiences depending on the route offered and the provider and placement that is chosen. The Carter Review criticised the variability in the attainment of subject-specific knowledge by trainees in all phases, including primary.

Respondents to ACME's survey noted the variability of mathematics pedagogy across providers. These criticisms are also reflected in Ofsted's work – in 2012 and 2013 Ofsted focused on the provision for primary trainees in mathematics and their outcomes and reported that primary mathematics ITE was weaker than for other subjects.²⁶ Ofsted recommended the need for the enhancement of subject knowledge and subject-specific teaching skills and remarked that the best ITE that was observed had:

- established a baseline of trainees' subject knowledge;
- focused on developing trainees' understanding of progression in strands of mathematics and teaching approaches that develop pupils' conceptual understanding.

The core ITE framework currently under development (see Box 7) should be extended to look at the mathematics-specific knowledge and pedagogical mathematics knowledge required by primary trainees.

Compared to some international jurisdictions, such as Shanghai and Singapore, trainees have less opportunity to develop mathematics and mathematics pedagogical subject knowledge. Only a small number of hours is dedicated to mathematics in many ITE providers in

England. Other jurisdictions can offer weeks or even months of subject-specific pedagogy, where ITE is often considerably longer than in England.²⁷

Given the current system in England, it is unlikely in the coming years that mathematics-specific education to master's level will be possible for all primary trainees. However, there is an urgent need for further investment in and incentives for increased numbers of primary mathematics specialists. In the medium term there must be a shared aim that all primary schools have access to a teacher with master's-level education in primary mathematics.²⁸ A plan for achieving this needs to be part of the overarching strategy for ITE of teachers of mathematics.

Recommendations:

During ITE primary trainees should have the opportunity to develop deep pedagogic knowledge of fundamental mathematics concepts.

A medium term priority is the development of a nationally-agreed framework, outlining the nature of pedagogical knowledge in mathematics required by primary teachers and suggested strategies to develop the subject and pedagogical knowledge required.²⁹

During the ITE course primary trainees should have:

- a minimum of 2 hours per week with a tutor focusing on pedagogic knowledge of fundamental mathematics concepts (72 contact hours)^{vi};
- a minimum of 2 hours per week of mathematics-specific directed study (72 hours).

These elements should be part of accreditation of ITE courses and inspection.

vi. This number is based on a 36 week course.

Where are we now?

Mathematics-specific education – Secondary

- Many trainees will have gained mathematics subject knowledge during their degree or SKE course but there may be gaps in their mathematics knowledge.
- Across ITE providers, there is no agreed mathematics-specific content for secondary ITE courses.
- By international standards, during ITE trainees currently spend comparatively little time on mathematics-specific pedagogy.
- During ITE, many trainees will not have adequate mathematics-specific education outside the classroom.

During ITE, secondary trainees should gain an understanding of mathematics-specific pedagogy, building on subject knowledge gained from their degree or SKE course. In the DfE's ITE criteria³⁰ it is stated that ITE providers should 'offer trainees specialist subject training to develop the necessary knowledge and understanding of their subject(s) and related pedagogy, which will enable them to teach their subject(s) across the full age and ability range of training'.

In other jurisdictions trainees spend months, and sometimes years, undertaking mathematics-specific ITE, as is the case in Singapore³¹ and Shanghai³². This often takes place away from the classroom. In the ACME Case Studies ITE providers found it difficult to quantify the amount of time that is spent on mathematics-specific pedagogy when asked to separate it from subject knowledge.³³ This is a difficult question that would likely be problematic for individuals within most ITE providers to answer, given the variety of content that has to be covered.

The Carter Review noted the variability of provision within comparable courses, where it was stated that 'there are important areas of content on subject-specific pedagogy that are not addressed on all courses'. In 2010 the Science and Learning Expert Group, which was tasked with looking at science and mathematics education, noted the lack of consistency across ITE programmes.³⁴ The Expert Group made a recommendation for further investigation into the balance of subject-specific and general pedagogical education in ITE courses to ensure that subject-specific pedagogy received a high priority.

There is also a need to develop shared understandings of what subject-specific pedagogy is required, in this case mathematics. This will take some time to develop and will require drawing on research and working with experienced ITE tutors. It would complement the non-subject specific core ITE framework (see Box 7).

Box 6: Subject Knowledge Enhancement (SKE) courses

- SKE courses are designed to help potential entrants to ITE gain the depth of subject knowledge and skills they need to be able to teach their chosen subject. Mathematics SKE courses are aimed at those deemed not to have sufficient mathematics for direct entry to a secondary mathematics ITE course.
- SKE courses may be completed before entering ITE, but in some cases are completed during an ITE course.
- SKE courses and ITE courses may be carried out by different providers.
- School Direct lead schools and other ITE providers allocated training places in mathematics can use funded SKE to support their recruitment. Schools can develop their own SKE courses.
- Courses last between 8 and 36 weeks and can sometimes be online. Trainees can apply for funding of up to £7,200.

In the short term, ITE providers can make some changes to ensure the prioritisation of pedagogical mathematics knowledge. Below, ACME sets out the minimum hours that should be spent on pedagogical mathematics knowledge. While this may seem like a significant increase for some ITE providers, it remains a much lower requirement than in many other jurisdictions.

Recommendations:

During ITE secondary trainees should have the opportunity to develop deep pedagogic knowledge of mathematics.

A medium term priority is the development of a nationally-agreed framework outlining the nature of the mathematical pedagogical content required in ITE courses and suggested strategies for its development.

Secondary trainees should have:

- a minimum of four contact hours with a mathematics-specific tutor each week (144 hours^{vii});
- four hours of directed study each week (144 hours).

These elements should be part of the accreditation of ITE courses and their inspection.

CASE STUDY 3

University D (secondary) – 25 PGCE; 25 Schools Direct (fee); 6 Schools Direct (salaried); 10 BSc Mathematics with Secondary QTS

The university noted the importance they placed on a balanced blend of input from universities and schools. For example, they acknowledged that up to date pedagogical experience is demonstrated well by colleagues working directly with learners in the classroom.

The university noted the need to ensure that the subject knowledge of trainees is appropriate and at an adequate level, but also emphasised their task of linking subject knowledge to the subject-specific pedagogy, so that teachers can teach learners of all abilities. However, the university acknowledged that much of their ITE courses is not subject specific. They noted that ‘as always, mathematics faces specific challenges because of shortages of experienced colleagues available to support trainees in many departments’. Directed study on mathematics pedagogy was described as usually focused on ‘the written assignments and the associated reading lists’.

Box 7: Core ITE framework

A recommendation from the Carter Review was to create a core framework for ITE courses in order to provide a more consistent experience for trainees. In response to the Review, the Government agreed that a ‘framework of the essential elements of core content would build a stronger shared understanding of good ITT content’. An Expert Group was formed in 2015 to develop a core framework.

vii. This number is based on a 36 week course.

What critical evaluation skills should trainees develop?

Where are we now?

Critical evaluation skills (see Box 8)

- The variety of ITE routes means that trainees spend different amounts of time in seminars and tutorials and in the classroom.
- The extent to which trainees engage with mathematics education research and develop critical evaluation skills is at the discretion of the provider.
- Not all trainees have the opportunity to develop the critical evaluation skills that are needed to become effective teachers.

An 18 month inquiry by the British Education Research Association (BERA) and the Royal Society for the Encouragement of the Arts, Manufacturing and Commerce (RSA) highlighted the contribution that research can make to the quality of teaching.³⁵ It was noted that ‘teachers and teacher educators can be equipped to engage with and be discerning consumers of research’. This chimes with ACME’s report *Empowering teachers: success for learners*, which emphasised the importance of practitioner inquiry, reflection on practice and engagement with research. The Carter Review also noted the need for reflective teachers who can review critically research evidence and utilise this for reflection on their practice. It was

recommended that the DfE’s Teachers’ Standards should be amended to emphasise the importance of teachers taking an evidence-based approach to teaching.³⁶

Currently in England, the place of research and critical evaluation varies across ITE routes. Some critics of recent reforms to ITE have expressed concerns that the shift away from university-led programmes will diminish the capacity of teachers to engage with research.³⁷ ACME’s Case Studies highlighted the variability of emphasis on research by ITE providers. Providers described various requirements, which included specific modules to learn about research skills, a final project on an area of teaching focused on the learning

CASE STUDY 4 University A - 42 Secondary PGCE

The university noted that trainees working towards a PGCE are required to complete a research assignment, the final of three assignments required for the PGCE. For this assignment, the trainee must identify an area of teaching that focuses on the learning of mathematics and must undertake ‘small-scale research’. The university noted that several lectures focus on the research assignment. The lectures are complemented by one-to-one support sessions. The assignment can be counted towards a master’s degree.

CASE STUDY 5

University C – 44 Primary PGCE (mathematics specialism); 20 Secondary PGCE, 10 School Direct (fee), 3 School Direct (salaried)

Trainees are required to complete a piece of action research over a half term, which is assessed by two 5000 word essays. Trainees are asked to focus on one issue with a single class. To complete the project, trainees are asked to attend research methods lectures and workshops on critical thinking skills and academic writing, among others. The school notes that this element of ITE ‘forms the focus of the “PG element”, rather than what is necessary for achieving QTS’.

Although school-based mentors are not required to be part of the research process, the school noted that some of them are. The local university invites mentors that are involved to present at a research conference.



of mathematics, action research and small-scale projects.³⁸ The current variability across providers may mean that some new teachers may not have gained the tools to become reflective practitioners, who are confident in reflecting on their own teaching and the teaching of others.

The increased number of ITE providers means that many more are involved in developing and supporting trainees than used to be the case. In recent years, there has not been an audit of the level of qualifications of those that are providing ITE in school-led and university-led settings. Ideally ITE tutors will have at least master's-level education, which will help to foster trainees' critical evaluation skills.³⁹

If critical evaluation skills are to be embedded in all ITE programmes, there will need to be buy-in from all ITE providers and all schools where trainees are placed. This may prove challenging unless it is set out in guidance for ITE providers, as well as in the DfE's Teachers' Standards. Further thinking may also be required to ensure that the means of developing critical evaluation skills fits in the school-led model. Monitoring of all routes is required.

Recommendations:

All ITE courses should provide trainees with the opportunity to develop the skills needed to become reflective practitioners who are able to evaluate and apply research on mathematics education and develop their own enquiries. Developing these skills requires ITE tutors who are themselves research skilled.

Primary and secondary trainees should be assessed on the development of these skills and their understanding of key research ideas.

Critical evaluation skills should be part of the accreditation of ITE courses and their inspection.

Box 8: Critical evaluation skills

Critical evaluation skills represent a teacher's facility to explore their own practice and that of others. It can involve the evaluation of research, analytical reflection, enquiry skills, lesson study or action research applied to the teacher's own practice.

What should mentoring look like and what mentoring should a trainee be entitled to?

Where are we now?

Mentoring

- Mentoring provision in both university- and school-led settings is varied.
- Some ITE providers offer mentor training and the option of gaining a qualification, as well as other rewards and incentives, while other provision is less structured.

In England, school-based mentoring has been a central feature of university and school partnerships since the 1980s. The Carter Review highlighted the importance of high-level mentoring by a mentor with strong subject-specific pedagogical knowledge.⁴⁰ The importance of mentoring is also reflected in the fact that mentoring is currently looked at as part of the Ofsted inspection during ITE⁴¹ and the induction period (NQT year).⁴²

A structured and subject-specific mentoring programme is a feature in many jurisdictions, where mentors receive dedicated training (Shanghai,⁴³ Singapore⁴⁴) and sometimes a qualification (Massachusetts⁴⁵). In all of these jurisdictions, there are clear roles and responsibilities for both mentors and trainees. Trainees continue to receive subject-specific mentoring in a structured programme even when ITE has been completed.

The English approach has been subject to criticism:

- **Status and recognition:** There are not clear roles and responsibilities for mentors. Mentoring is not recognised in career progression frameworks and salary structures.⁴⁶
- **Variability of provision:** Ofsted's 2013 – 14 review of ITE providers stated that the quality of mentoring and subject-specific feedback for trainees needed to be improved.⁴⁷
- **Selection and training:** There are not rigorous ways to select and train mentors. Respondents to ACME's Survey highlighted that there are few prerequisites for mentors, aside from not being a NQT. Also, in ACME's Case Studies, the different approaches towards training mentors were clear. Training for mentors varied from a one day conference held by one provider to weekly contact and training provided by a university in another.

For a mentoring programme to be successful, mentors must have a role beyond generic pedagogic support. At ACME's roundtable held in March 2015, participants noted the importance of mentors having a strong understanding of mathematics to guide trainees and new teachers to develop their classroom practice.⁴⁸ At primary level, not all mentors will have deep mathematical knowledge. If this is the case, the mentor should have a responsibility to know where and when a trainee or new teacher should access this knowledge.

In England, a three year mentoring programme would provide each trainee with subject-specific support and guidance in the early years of their professional practice. Such a move towards a more structured mentoring programme would require commitment from ITE providers and schools and the development of shared understandings of the roles and responsibilities of both mentor and mentee. The programme would form part of a broader training and accreditation system. In this way, mentoring would be seen as a valued role for a teacher and an important part of the professional journey of teachers of mathematics.

“Mentors need to be confident in their own subject knowledge, be recognised expert teachers of the subject and also have the skills to mentor.”

ACME Survey: Higher education respondent.

CASE STUDY 6

University B – 120 secondary PGCE (20 secondary mathematics); 90 primary PGCE; 30 primary School Direct (fee)

The university noted that to become a mentor teachers have to attend one day of training, which involves an in-depth exploration of the skills required to support trainees and new teachers. The university appoints a visiting tutor who is responsible for quality assuring the provision and support given. The visiting tutor has a checklist to ensure that things happen on time and the tutor makes contact with the school, mentor and trainee as soon as the placement begins.

The university requires that mentors update their training every three years. Mentors receive a certificate to acknowledge that they have undergone training and they have the opportunity to undertake master's level training. The university noted that they have an evaluation process at the end of each semester for regular feedback about mentors. They note that any shortcomings in the quality of support is followed up by the School Experience academic team.

CASE STUDY 7

Teach First – 1010 secondary trainees and 251 primary trainees (2013 – 2014)

There is a structured mentoring programme which Teach First describe as a detailed support model during the first year working towards QTS and during the NQT year.

Some key roles:

- School-based Subject-specific mentor
- School-based Professional mentor
- University-based Subject-specific mentor
- University-based Professional mentor
- Leadership Development tutor for professional and leadership skills development
- Associate tutor (someone who is currently teaching, typically an ambassador of the programme).

For mentors, there is a mentor development programme and a mentor recognition framework. The mentor programme is not subject-specific in nature. Mentors are encouraged to attend university sessions with teachers, but it was admitted that it can be difficult to have teachers released from their teaching duties.

Recommendations:

Trainees and new teachers should have regular access to extensive mathematics-specific mentoring. Trainees and new teachers should have regular sessions with mentors during ITE and will also receive mentoring for at least two years after achieving Qualified Teacher Status (QTS).

- At primary level mentors should recognise when trainees require subject-specialist support and should know how trainees can access local expertise. Mentors should receive training before mentoring trainees and new teachers.
- At secondary level mentors should be mathematics specialists and experienced teachers. Mentors should receive training before mentoring trainees and new teachers.

Clarity is needed about the roles and responsibilities of mentors, trainees and new teachers as well as the roles and responsibilities of ITE providers and schools. In the medium term, a structured training programme for mentors is required.

The more formal arrangements for mentoring should be reflected in the accreditation and inspection of ITE providers.

How can a professional learning environment be fostered in ITE and during the first years of teaching?

Where are we now?

Linking ITE and early stage professional development

- The links between ITE and professional development are often weak.
- Those providing ITE and supporting trainees and early career teachers should have a responsibility to instil the understanding that professional development is essential. However, roles and responsibilities are not clear.

During ITE

In the Carter Review it was emphasised that 'it is critical to remember that ITT is initial. We believe ITT providers, teacher educators and mentors should be absolutely explicit about this - emphasising to trainees the need to develop further as an NQT, in their early career and beyond'. ITE providers and the schools in which trainees are placed should have the responsibility to instil the understanding that trainees are only beginning their learning as a teacher. However, this will be challenging for providers, schools and trainees without more guidance for teachers and senior leaders about what is expected of them in terms of professional development. The current DfE Teachers' Standards only require that teachers 'keep their knowledge and skills as teachers up-to-date and are self-critical' and 'take responsibility for improving teaching through appropriate professional development'. No further detail is given.

Since June 2014 Ofsted carries out a two-stage approach to ITE inspections, looking at both the ITE year and the NQT year.⁴⁹ Ofsted examines, among other things, a trainee's professional development and the provider's, mentor's and trainee's contribution to this. This development provides an opportunity to improve ITE and professional development linkages.

Further guidance would also be useful for ITE providers, schools and trainees, so that all parties can understand their roles and responsibilities at this very early stage of a teacher's development. This guidance might set out the importance of accessing various networks that already exist, including subject associations and learned societies.

After ITE

In the Carter Review, it was stated that 'schools must understand that when they employ an NQT they are taking on a responsibility as well as a great opportunity. It is critical that progression between ITT and the NQT year is as seamless as possible'. Currently in England, new teachers are supported through an induction programme during their NQT year. Statutory guidance sets out obligations for both the school and for the NQT.

Many schools and colleges recognise the centrality of professional development to good teaching and learning and innovative programmes have been developed. However, a new teacher's professional development in England remains dependent on the ITE providers and on the schools in which trainees begin their teaching career. There is no structured professional path for new teachers of mathematics. In Shanghai, teachers have 240 hours of professional development within 5 years in a structured programme, while in Singapore a structured programme of professional development with 500 hours over five years is provided for new teachers. In Massachusetts, licensing is dependent on sustained professional development. It may be that greater links need to be developed between ITE providers and schools. ACME's Case Studies show that the majority of providers described their support for NQTs as ad hoc and informal. Incentives for ITE providers and schools may need to be developed.

There are some promising signs about the recognition of professional development in schools. In Ofsted's recently introduced two-stage approach to ITE inspections, the professional development accessible to and known to NQTs will be looked at.⁴⁹ In addition, the 2015 Ofsted inspection handbook asks inspectors to look at the 'quality of continuing professional development for teachers at the start and middle of their careers and later'.⁵⁰

The challenge remains to develop and embed a shared understanding of professional development pathways that guides ITE providers, schools and colleges, senior leaders, teachers and trainees. The Professional Development Standard under development in 2015 – 16 may be something that could be built on.⁵¹ This would extend its relevance to the importance and benefits of all teachers engaging with subject-specific professional development.⁵²

Early career professional development is essential to get right, given that the DfE estimates that 50% of classroom teacher vacancies each year are taken by new entrants.⁵⁷ To ensure that these teachers stay in the classroom, a three year structured programme of subject-specific professional development is required, that is, during ITE, the NQT year and the year after. It may be that the developing College of Teaching has a role to play in the professional development of new and early career teachers, as well as throughout their careers.⁵⁴

Recommendations:

There should be clear roles and responsibilities for trainees, new teachers and ITE providers, so that:

- ITE is seen as the first step on the journey as a mathematics teacher;
- there is an understanding of the entitlement and responsibility to engage with high-quality mathematics professional development throughout a teacher's career.

In the short to medium term, a professional learning journey for all teachers of mathematics, including primary teachers, needs to be developed. This must highlight mathematics-specific requirements. This guidance should draw on the expertise of the mathematics education community and be based on research.

CASE STUDY 8

School 2 (secondary) – 12 School Direct trainees (3 secondary mathematics)

With regard to support for new secondary teachers, the school noted that all NQTs are assigned a mentor in addition to an induction tutor. The mentor and trainee meet regularly to discuss teaching and learning and areas to improve. The mentor is asked to design a bespoke professional development programme for the NQT, for example on behaviour management or subject knowledge. The school requires that mentors and trainees write a termly report. The report should draw on joint lesson observations, with input from both the mentor and the induction tutor. The school encourages NQTs to go on external professional development courses and to visit other schools and academies for further experience of teaching.

"It is not possible to front load this knowledge in advance of substantial practice, i.e. it is necessary to prepare trainees for a professional culture of lifelong learning."

ACME Survey: Higher Education researcher and former mathematics teacher.

5 Section B: A long-term strategic plan for the ITE of teachers of mathematics

The focus in this report has been on what high-quality education for teachers of mathematics should look like. However, ACME recognises that the quality of education cannot be separated from the acute shortages of teachers of mathematics.

There are challenges in the recruitment, upskilling, professional development and retention of teachers of mathematics. ACME cannot explore these issues in great depth here, but more detailed analysis is being carried out in 2015 – 2016.⁵⁵ Here, some of the main issues for concern are set out, before an argument is made for the development of an action plan for the initial teacher education of teachers of mathematics.

The supply of teachers of mathematics and the education of the teaching workforce: Four challenges.

CHALLENGE 1

ITE providers and routes into ITE

- **ITE is being delivered in a variety of different ways.**⁵⁶ There are several routes into initial teacher education (some are summarised in Box 2), there are over 140 providers of ITE in England and trainees were placed across 939 schools in 2014.⁵⁷ The diversity of routes into teaching and increase in the number of providers has led to concerns about the equity of ITE provision. For example, Ofsted has noted geographic inequities in provision and has warned that good and outstanding schools at the centre of a school-led model have first call to ‘cherry pick’ the best applicants.⁵⁸
- **There has been a shift from university-led provision to school-led provision.** This has prompted concern about the speed and depth of change putting the long-term stability of the system at risk. While university-led providers filled over 90% of their allocated places in 2013 – 14, about 60% of school-led places were filled.⁵⁹
- **There have been some concerns about School Direct (salaried) provision.**⁶⁰ Although Ofsted did not inspect School Direct during its first years in operation, in its 2013 – 14 report Ofsted stated that the large majority of partnerships were involved

in School Direct, where much good practice was seen. However, they noted some concerns about the quality of ITE, particularly on the secondary School Direct (salaried) route.⁶¹

- **Different routes through ITE lead to different qualifications, which may not be well understood by learners or employers.** Trainees may not understand that different qualifications will have different currency in other jurisdictions. A DfE-commissioned study involved focus groups with trainees and new teachers, who expressed confusion about the routes available and the incentives to follow different routes.⁶²
- **There have also been concerns about financial instability within the sector.** For example Universities UK has argued that how and when funding for ITE is allocated could potentially lead to the closure of large providers of ITE.⁶³

CHALLENGE 2

Recruiting new teachers of mathematics

- **Every year many more teachers of mathematics are needed.** 3,000 teachers of mathematics are needed each year and it is acknowledged that the DfE needs to look beyond the 8,000 mathematical science⁶⁴ graduates per year to fulfil these needs. The DfE has recognised the importance of recruiting new teachers of mathematics and has developed bursary and scholarship schemes to improve recruitment numbers.⁶⁵ There are also bursaries for primary mathematics specialists (see Box 4). Analysis of the benefits of these programmes is required.
- **There is an increasing need for more teachers of mathematics with mathematics-specific teaching qualifications.** At secondary level, an estimated 5,410 extra specialist teachers are needed to teach the mathematics lessons currently taught by non-specialists, that is those without a A level in Mathematics.⁶⁶

- In addition, learners will have to continue to take GCSE Mathematics post-16 if they have not received a Grade C, requiring thousands more teachers in the schools and further education sector. For Core Maths to be successful, thousands of teachers will require upskilling.
- The school population is growing and it is expected that by 2023 there will be 900,000 more primary learners, 9% more than in 2014 and 480,000 more secondary learners, 17% higher than 2014.⁶⁷
- **Schools are finding it difficult to fill their vacancies.** Ofsted conducted a survey of teacher recruitment in schools which showed that less than a third of schools had a good choice of well-qualified entrants for all teaching posts advertised in 2013 – 14.⁶⁸ Subject-specific data for mathematics was not provided by Ofsted. However, there is anecdotal evidence that the problem is particularly acute for mathematics recruitment.

CHALLENGE 3

Retention

- **Many teachers of mathematics leave within three years of completing ITE.** Across subjects, almost one in four teachers leaves teaching within five years.⁶⁹ Every teacher lost represents another who needs to be trained.
- **The cost of training teachers needs to be analysed and compared with the cost of professional development and other possible ways of retaining teachers.** Ofsted Chief Inspector Michael Wilshaw stated that “It is a national scandal that we invest so much in teacher education and yet an estimated 40% of new entrants leave within five years.”⁷⁰
- **There is a dearth of knowledge about who leaves the classroom and why teachers leave the classroom.** There needs to be much more data collected on why teachers, in this case teachers of mathematics, leave the profession of teaching.⁷¹ This can be used to consider the cost of addressing the reasons behind early departure.

CHALLENGE 4

Professional development

- **Even dramatic increases in the recruitment of teachers of mathematics cannot wholly solve the problem of teacher supply.** The importance of professional development for teachers of mathematics has been recognised by the Government, which has invested in the Maths Hubs to improve the professional development of teachers of mathematics across England.⁷²
- **There are concerns about** accessibility to subject-specific professional development and geographical equity in terms of provision.⁷³ There is a need to create a map of formal professional development activities in order to establish what professional development is available to whom, where, of what quality and for what cost.
- **Mathematics-specific professional development for all teachers of mathematics is essential.** There has been significant, and welcome, investment in the professional development of teachers of mathematics.⁷⁴ However, high-quality subject-specific professional development should be available to all teachers of mathematics, teaching across all phases.
 - Ofsted has reported that there is significant variation in the quality of mathematics teaching, even in good and outstanding schools and found that non-specialist, less experienced or non-permanent teachers are more likely to teach learners in lower sets.⁷⁵
 - Key Stage 3 teachers often do not have a qualification in mathematics⁷⁶ and Ofsted has also noted that Key Stage 3 is often not a high priority for secondary leaders.⁷⁷

6 Planning for the future

If the supply of teachers is further affected at a time when there is an increasing need for more teachers of mathematics and related subjects, then the challenges now being experienced will be even greater. As noted above, the Government has acknowledged that the issue of mathematics teaching supply is very important. There are a number of initiatives aimed at recruiting and upskilling of teachers of mathematics and incentives in the form of bursaries and scholarships, both at primary and secondary level.⁷⁸ **However, more needs to be done and a range of organisations need to work together to set out an action plan for the future of ITE for teachers of mathematics.** Figure 4 sets out some of the priorities that need to be subject to further discussion and analysis.

In order to develop a long-term strategic plan for the ITE of teachers of mathematics, ACME recommends:

- A. Investment in data collection, analysis and monitoring:** When undertaking the research for this report ACME noted that in many cases data was not available. Without a clear picture of the current and potential workforce, it will be more difficult to plan for the future. Much better information on the recruitment and retention cycles is needed. Continual monitoring is also needed, of routes and of supply, which must be utilised to inform policy.
- B. Development of clear lines of accountability:** Currently a range of actors play a role in ITE provision (see Box 10). An overarching strategy would be most effective if there were clear lines of responsibility and accountability. More clarity is needed about what this means at a local, regional and national level for future mathematics ITE supply. Further consideration needs to be given about who leads on the ITE strategy.^{viii}
- C. Mapping initiatives and identifying gaps to develop an action plan:** All of the current programmes and initiatives to improve ITE supply must be mapped in order to identify gaps. It might be that current initiatives are extended or developed

to feed into the plan, whereas other new plans will need to be developed. The mapping exercise and identification of new areas of development will feed into a long standing and overarching action plan for ITE of teachers of mathematics. This should be a long-term programme with all party buy-in.

The overarching strategic plan should be developed collaboratively by all of those involved in the provision and support of ITE, including governmental bodies, ITE providers, schools and colleges, learned societies, professional bodies and subject associations and education researchers.

Box 10: Some current roles and responsibilities in ITE

The Department for Education is responsible for the teaching and learning of young people (under 19) and supporting the professionals that work with them, including trainees and qualified teachers.

The National College for Teaching and Leadership (NCTL) (DfE executive agency) is responsible for ensuring that enough trainees enter ITE to meet the needs of the sector. It manages the allocation of ITE places and related funding to ITE providers. NCTL awards Qualified Teacher Status. It runs the School Direct Programme and is responsible for the allocation of subject knowledge enhancement courses.

Ofsted (non-ministerial department) is responsible for inspecting and reporting on ITE programmes that lead to QTS.

ITE providers (HEI – and school-led) are responsible for delivering ITE programmes, ensuring applicants have achieved the minimum qualification standards required to enter ITE and for deciding the content of ITE courses.

viii. Is there a need for a new body to be set up, either within or outside parliament? Or should the NCTL take on further roles and responsibilities? Or should responsibility be taken on by an emerging body like the College or Teaching?

Figure 4: Towards a long-term strategic plan for ITE of teachers of mathematics: essential first steps.

Investment in data collection, analysis and monitoring

Data	Monitoring
<p>> Collection of high-quality data about the teaching workforce. This would include information on supply, recruitment and retention, with data broken down by geographic location, demographic information, school type and Ofsted category.</p>	<p>> Establishment of a monitoring system into the short-, medium-, and long-term effectiveness of various routes into ITE. This monitoring system would be fed into the overarching plan on teacher supply and teacher training and development.</p>

Development of clear lines of accountability

Accountability for teacher supply and professional development

- > Identification of who is accountable for target setting for future mathematics ITE supply at a local, regional and national level.
- > Consideration given to the development of regional strategies for ITE supply and professional development.

Mapping initiatives and identifying gaps to develop an action plan

Currency of qualifications	Consistency across ITE programmes
<p>> Clarification around the value and recognition accorded to different teacher qualifications, for example QTS.⁷⁹</p>	<p>> Development and implementation of core mathematics-specific content across primary and secondary ITE courses.</p> <p>> Clarity about the place of critical evaluation skills in primary and secondary of ITE courses.</p>
Mentor programmes	SKE courses
<p>> Establishment of a process for the accreditation of school-based subject specialist mentors.</p> <p>> Development of a structured model for mentor training.</p>	<p>> Establishment of a system for quality assurance and accreditation of SKE courses with clear lines of accountability.</p>
Subject-specific professional development	A focus on mathematics at primary level
<p>> Establishment of a shared understanding of the mathematics professional needs of teachers.</p> <p>> Creation of better links between ITE, professional development and further qualifications, such as master's level education.</p>	<p>> Development of an action plan:</p> <ul style="list-style-type: none"> • to raise the mathematical requirements needed for entry to ITE courses; • to move towards every primary school in England having local access to a mathematics specialist educated to master's level.



References

1. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/399957/Carter_Review.pdf.
2. <https://www.gov.uk/government/collections/ofsted-annual-report-201314>.
3. <https://www.gov.uk/government/publications/teachers-standards>. The Teachers' Standards define the minimum level of practice expected of trainees and teachers from the point of being awarded qualified teacher status (QTS). The Teachers' Standards are used to assess all trainees working towards QTS, and all those completing their statutory induction period.
4. <https://www.gov.uk/government/publications/initial-teacher-training-allocations-for-academic-year-2015-to-2016>. The allocations system for postgraduate course was adapted for 2016 and 2017 to allow schools, SCITTs and HEIs to take on as many trainees as they can.
5. <http://www.acme-uk.org/media/14054/acmepdreport2013.pdf>.
6. <http://www.acme-uk.org/media/20263/teachersofmaths.pdf>.
7. ACME undertook a review of some of the elements of the ITE system, in four jurisdictions (Germany, Massachusetts, Shanghai and Singapore) in addition to England. These jurisdictions were chosen for their known improvement in education performance and higher achievement in mathematics than England in recent years. These elements included entry requirements to ITE, mathematics-specific education, mentoring provision, the emphasis on research practice during ITE and the commitment to professional development for teachers of mathematics. See <http://www.acme-uk.org/media/24413/acmeitehaveyoursay2015.pdf> for more detail.
8. ACME commissioned a team of researchers to undertake a 8 case studies on higher education and school-led providers.
9. Responses were received from a range of approximately 70 individuals and organisations from the education community, including subject associations, teachers, ITE providers, trainees and researchers.
10. <https://www.gov.uk/government/publications/initial-teacher-training-allocations-for-academic-year-2014-to-2015>. There are a number of groups not included in these allocations, including Teach First.
11. <https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2014-to-2015>. Teach First, for example, is excluded from these allocations in DfE data.
12. Other ITE elements identified included subject knowledge development, subject-specific pedagogy, evidence-based teaching, child and adolescent development, behaviour management, planning, assessment, differentiation, Special Educational Needs and Disabilities (SEND) and Professionalism.
13. Deep pedagogic subject knowledge includes what is referred to as pedagogical content knowledge in Deborah Ball, Mark Hoover Thames, and Geoffrey Phelps, *Content Knowledge for Teaching: What Makes It Special?* Journal of Teacher Education November/December 2008 59: 389 – 407 and also Ofsted's 'understanding of progression in strands of mathematics and teaching approaches that develop pupils' conceptual understanding' and 'necessary knowledge and understanding and related pedagogy', <https://www.gov.uk/government/publications/promoting-improvement-in-initial-teacher-education-primary-mathematics>.
14. <https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2013-to-2014>
15. ACME has long advocated more learners doing more mathematics post-16. See ACME's reports on post-16 mathematics: <http://www.acme-uk.org/policy-advice/qualifications-and-assessment/mathematics-for-all-to-18/core-maths>.
16. England is unusual as few learners continue taking mathematics until the end of their schooling, http://www.nuffieldfoundation.org/sites/default/files/files/1s%20the%20UK%20an%20Outlier_Nuffield%20Foundation_v_FINAL.pdf.
17. This may enable trainees to maintain and develop mathematics skills to use in realistic contexts and to have a firmer foundation on which to build the mathematical knowledge needed for primary teaching.
18. ITE census data showed that 2,230 of entrants were on postgraduate ITE programmes and 90 on undergraduate programmes, <https://www.gov.uk/government/statistics/initial-teacher-training-trainee-number-census-2013-to-2014#history>.
19. In some cases, a SKE course will be taken alongside an ITE course. Teach First requires a B, A or A* in A level Mathematics and a 2:1 degree in any subject.
20. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434608/ITT_criteria.pdf.
21. By 2025 – 26, there is an estimated need for 32,059 mathematics teachers. This means around 3,000 entrants needed every year, over one third of the pool of mathematics graduates, <https://www.gov.uk/government/publications/teacher-supply-model>.
22. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/455324/SKE_Operations_Manual_15-16.pdf.
23. ACME Survey: University Lecturer in Education.
24. <http://www.ametonline.org.uk/resources/SKE+best+practice+AMET.pdf>.
25. This would be what is currently categorised by the DfE as a 'long SKE', between 24 and 36 weeks, <https://www.gov.uk/guidance/subject-knowledge-enhancement-an-introduction#related-documents>. AMET notes that longer SKEs (four months at least) generally focus on AS and A level mathematics but also cover parts of the Key Stage 3 and 4 syllabus. Short SKEs (8 weeks) may only cover GCSE Mathematics.
26. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/403142/Promoting_improvement_in_Initial_Teacher_Education_primary_mathematics.pdf.
27. <http://www.acme-uk.org/media/24413/acmeitehaveyoursay2015.pdf>.
28. http://childrens-mathematics.net/williams_maths_review.pdf and <https://royalsociety.org/~media/education/policy/vision/reports/vision-full-report-20140625.pdf>.
29. A starting point might be the guidance developed by the NCETM and AMET for Primary Mathematics Specialist teachers (2014), <http://www.ametonline.org.uk/resources/Primary+mathematics+specialism.pdf>. They set out some the 'big ideas' in mathematics that should be covered during a course.
30. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434608/ITT_criteria.pdf.
31. http://www.fisme.science.uu.nl/publicaties/literatuur/2012_iea_teds_m.pdf.
32. <http://www.ncee.org/programs-affiliates/center-on-international-education-benchmarking/top-performing-countries/shanghai-china/shanghai-china-teacher-and-principal-quality/>.
33. ACME Case Study: University C noted that trainees spent Fridays in the university, spending two and a quarter hours (one third of the time allocated), on subject-specific development.
34. <http://webarchive.nationalarchives.gov.uk/+http://www.bis.gov.uk/wp-content/uploads/2010/02/Science-Learning-Group-Report.pdf>.
35. <https://www.bera.ac.uk/get-pdf.php?pdf=wp-content/uploads/2013/12/BERA-RSA-Research-Teaching-Profession-FULL-REPORT-for-web.pdf>.

36. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/301107/Teachers__Standards.pdf.
37. <https://www.bera.ac.uk/project/research-and-teacher-education>.
38. A Teach First NQT noted that 'all subject-specific days need academic reading in advance'. She also said that throughout the year Teach First workshops focus on reflection and said that there is a 'reflective practitioner emphasis in training'. Teach First Case Study.
39. The Royal Society's Vision for science and mathematics education report recognised that education policy and practice need to be better informed by evidence, <https://royalsociety.org/~media/education/policy/vision/reports/vision-full-report-20140625.pdf>. The Royal Society is following up the report's recommendations with a programme of work examining the structure, status and funding of education research, in order to provide advice on ways in which education research in the UK can be strengthened.
40. In 2015 the Teaching Schools Council (TSC) was tasked with developing mentor standards.
41. During stage one of the inspection, inspectors are likely to request evidence of the experience and expertise of mentors and trainers and evidence of the professional development provided for mentors and trainers, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407861/Initial_Teacher_Education_handbook_from_1_April_2015.pdf.
42. During the induction period, the induction tutor may not be trained in the same subject as the trainee and therefore may not have mathematics-specific knowledge. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/375304/Statutory_induction_for_newly_qualified_teachers_guidance_revised_October_2014.pdf. Some schools will also have a mentoring programme during the NQT year to supplement this induction. In other cases, a 'mentor' covers both roles.
43. <http://ro.ecu.edu.au/cgi/viewcontent.cgi?article=1928&context=ajte>.
44. <http://www.moe.gov.sg/media/press/2006/pr20060126.htm>.
45. <http://www.newteachercenter.org/sites/default/files/ntc/main/resources/brf-ntc-policy-state-teacher-induction.pdf>.
46. http://shura.shu.ac.uk/7224/1/Hobson_and_Malderez_2013_Judgementoring_IJMCE_Post-print_draft.pdf.
47. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384707/Ofsted_Annual_Report_201314_Schools.pdf.
48. <http://www.acme-uk.org/events/events-repository/2015/3/initial-teacher-education-round-table>.
49. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/459282/Initial_Teacher_Education_handbook_from_September_2015.pdf.
50. <https://www.gov.uk/government/publications/school-inspection-handbook-from-september-2015>.
51. <https://www.gov.uk/government/groups/teachers-professional-development-expert-group>.
52. In 2015 – 16 an ACME-convened expert panel will look at the professional development learning journey for teachers of mathematics.
53. <https://johnhowson.wordpress.com/2015/07/>.
54. It is stated on the College of Teaching website that 'the establishment of the new College of Teaching will ensure the profession is given the status, aspiration and professional pathways recognised by chartered bodies in other professions', http://www.collegeofteachingtrustees.com/sections/about_the_org.
55. On the mathematics teaching workforce, see Nuffield Foundation (forthcoming) and Gatsby Foundation, <http://www.gatsby.org.uk/uploads/education/reports/pdf/profile-of-the-maths-teaching-workforce.pdf>; The National Audit Office (forthcoming) is examining whether the system for training new teachers produces sufficient numbers of new teachers of the right quality for schools and whether the DfE has effective oversight of the market for training new teachers, <http://www.nao.org.uk/work-in-progress/training-new-teachers-2/>.
56. http://plscitt.org.uk/uploads/Documents/Our%20Programme%20Files/routes_into_teaching_map_final.pdf.
57. https://www.ucas.com/sites/default/files/utt_eoc_2014_eoc_15_03_27_1.pdf
58. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384699/Ofsted_Annual_Report_201314_HMCI_commentary.pdf.
59. <http://www.universitiesuk.ac.uk/highereducation/Documents/2014/ImpactOfITTreformsOnEnglishHEIs.pdf>.
60. School Direct, set up in 2012, was not inspected in its first years of existence as Ofsted does not inspect 'innovative' routes. However, there was indirect inspection of School Direct as visits to schools often formed part of the inspection of higher education institutes of school-centred ITE.
61. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384699/Ofsted_Annual_Report_201314_HMCI_commentary.pdf.
62. <http://dera.ioe.ac.uk/21224/1/journey-to-teacher-training-research-report.pdf>.
63. <http://www.universitiesuk.ac.uk/highereducation/Documents/2014/ImpactOfITTreformsOnEnglishHEIs.pdf>.
64. <https://www.hesa.ac.uk/>.
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66. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335413/sfr11_2014_updated_july.pdf.
67. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/330261/SFR23_2014_Main_Text.pdf.
68. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384707/Ofsted_Annual_Report_201314_Schools.pdf.
69. <https://data.gov.uk/dataset/the-database-of-teacher-records>.
70. <http://www.theguardian.com/education/2014/jan/15/ofsted-chief-teachers-quitting-scandal>.
71. DfE figures show that in the 12 months to November 2014 almost 50,000 qualified teachers in England left the state sector, <https://www.gov.uk/government/statistics/school-workforce-in-england-november-2014>.
72. <https://www.gov.uk/government/news/network-of-32-maths-hubs-across-england-aims-to-raise-standards>.
73. <http://tdtrust.org/wp-content/uploads/2015/06/Developing-Great-Teaching-Summary.pdf>.
74. <https://www.gov.uk/government/news/maths-and-science-must-be-the-top-priority-in-our-schools-says-prime-minister>.
75. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/417446/Mathematics_made_to_measure.pdf.
76. <https://www.gov.uk/government/statistics/school-workforce-in-england-november-2014>.
77. <https://www.gov.uk/government/publications/key-stage-3-the-wasted-years>.
78. <https://www.gov.uk/government/news/major-push-to-get-more-maths-and-physics-teachers-into-our-classrooms>.
79. Some qualifications enable a teacher to teach in a wide variety of jurisdictions. Those gaining the basic QTS, however, will find that they are not qualified to teach in some other countries, for example Scotland.

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The ACME Outer Circle

Participants at ACME's round table on initial teacher education, 18 March 2015

Respondents to Initial teacher education of teachers of mathematics at primary and secondary: have your say.

Participants interviewed for the case studies of initial teacher education commissioned by ACME

Representatives at the Meeting of the Mathematical Subject Associations (MMSA)

The Royal Society staff

Summary of recommendations

Some key elements for the effective ITE of teachers of mathematics	
Entry qualifications	<p>Primary Entrants to ITE should have at least a Grade C (Grade 5) in GCSE Mathematics or equivalent. In the long term, entrants should have a qualification in mathematics at Level 3.</p>
	<p>Secondary Entrants to ITE should have a firm foundation in mathematics subject knowledge, either gained from degree-related study or from a regulated subject knowledge enhancement (SKE) course.</p>
Mathematics-specific education	<p>Primary ITE should enable trainees to develop in-depth pedagogical subject knowledge in mathematics.</p>
	<p>Secondary ITE should enable trainees to build on their mathematics and develop deep pedagogical subject knowledge.</p>
Critical evaluation skills	<p>Trainees should become research literate: they need to develop critical evaluation skills, which can involve evaluation of research, analytical reflection, enquiry skills, lesson study and action research. These skills should allow teachers to explore their own practice and that of others.</p>
Mentoring	<p>Primary Trainees should be in a structured mentoring programme with a school-based trained mentor who recognises when trainees require mathematics-specialist support and knows how to access this.</p>
	<p>Secondary Trainees should be in a structured mentoring programme with a school-based trained mathematics specialist mentor.</p>
	<p>Mentoring should continue during the Newly Qualified Teacher (NQT) year and the following year.</p>
Linking ITE and early stage professional development	<p>ITE and early stage professional development should be more closely aligned and there should be clear stages for progression. A structured three year professional development programme is required, which runs during ITE and continues two years after ITE. There should be clear roles and responsibilities for those providing and supporting ITE and for trainees.</p>



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