1. About MEI

1.1. MEI\(^1\) is an independent charity. MEI’s mission is to improve maths education. Our work is described in our Annual Review.\(^2\)

2. Executive Summary

2.1. All STEM skills are underpinned by maths and effective maths education is essential to close the STEM skills gap.

2.2. The UK has very low levels of participation in post-16 maths education compared with our economic competitors.\(^3\)

2.3. MEI, particularly through its development and management of the DfE-funded Further Mathematics Support Programme\(^4\) (FMSP), has done much to support the very strong growth in the numbers of students taking AS and A level Mathematics and Further Mathematics since 2005. However, participation in maths education beyond GCSE level post-16 is still far lower than in many of the UK’s competitor economies.

2.4. Recent work to develop new post-16 ‘Core Maths’ qualifications and to reform the maths curriculum at GCSE and at AS/A level was intended to help address this situation.

2.5. The many recent maths curriculum reforms have the potential to be very positive, but their implementation requires far more support.

2.6. The current policy on post-16 GCSE Mathematics resit is resulting in very high failure rates and should be reviewed\(^5\).

2.7. Education funding reforms mean that school sixth forms and Sixth Form and Further Education colleges are feeling a strong squeeze on funding for post-16 education, which is limiting, and in many cases reducing their maths provision.\(^6\)

2.8. A shortage of suitably qualified maths teachers is compounding the problems.\(^7\)

2.9. As a partner in the consortium that manages the DfE-funded National Centre for Excellence in the Teaching of Mathematics\(^8\), MEI has been instrumental in setting up and coordinating the national Maths Hubs\(^9\) network. Part of the work of the Maths Hubs is to help coordinate support for post-16 maths, but more support is needed.

2.10. Maths education is at a crossroads; much good work has been done that could be built upon with sufficient, continuing investment. Without such investment the recent curriculum changes could prove counter-productive and progress made over recent years could be reversed, widening the STEM skills gap.

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\(^1\) MEI, Mathematics in Education and Industry, [www.mei.org.uk](http://www.mei.org.uk)


\(^4\) The Further Mathematics Support Programme, [www.furthermaths.org.uk](http://www.furthermaths.org.uk)


\(^6\) ‘How are post-16 curriculum and funding changes affecting A level Further Mathematics provision?’, FMSP, April 2016, [http://www.furthermaths.org.uk/docs/Effects-curriculum&funding-changes.pdf](http://www.furthermaths.org.uk/docs/Effects-curriculum&funding-changes.pdf)


\(^8\) The National Centre for Excellence in the Teaching of Mathematics, [https://www.ncetm.org.uk/](https://www.ncetm.org.uk/)

3 Post-16 pathways, so all study maths to age 18, as found in competitor economies

3.1 Current situation

3.1.1 Compared with other developed countries, the UK has very low levels of participation in maths education post-16.\(^\text{10}\)

3.1.2 Over 300 000 students each year who achieve a level 2 pass in GCSE Mathematics (grade C or above in the pre-2017 GCSE Mathematics, currently grade 4 or above for the new GCSE Mathematics\(^\text{11}\)) at age 16 choose not to study maths post-16.

3.1.3 To address this concern, the Further Mathematics Support Programme (FMSP) has done much to increase the numbers of young people choosing to study maths at AS and A level (see section 4), and new ‘Core Maths’ qualifications have been introduced (see section 5).

3.1.4 Core Maths is designed to be accessible and useful to all who have passed GCSE Mathematics at grade C or above, and so has a potential annual cohort of over 300 000. It aims to teach students how apply basic maths and statistics to solve quantitative problems and analyse data in practical situations.

3.1.5 Some other post-16 programmes, such as the International Baccalaureate and some level 3 vocational programmes, also include level 3 maths content (maths beyond GCSE level).

3.1.6 Since 2015, all students who fail to achieve a level 2 pass in GCSE Mathematics are required to re-take it post-16, or to take a ‘stepping stone’ qualification\(^\text{12}\), such as Functional Mathematics\(^\text{13}\), leading towards a level 2 GCSE pass.

3.1.7 The intention of these pathways is to provide an appropriate route for all students to study maths post-16. The idea is good, but there are serious problems with its implementation.

3.2 The following sections address different aspects of these pathways in detail, explaining how MEI’s work supports them and recommending what is required to help implement them successfully. Since mathematics underpins the whole of STEM education, successful post-16 maths pathways are essential to closing the STEM skills gap.


4. The mathematics AS and A level qualifications

4.1 Current situation

4.1.1 The uptake of AS and A level Mathematics and AS and A level Further Mathematics has grown strongly in recent years, but growth seemed to stall in 2016. This was partly due to a reduction in the overall numbers of students taking A levels; however, FMSP evidence suggests this was also because of funding restrictions in schools and colleges, particularly in relation to the AS levels.

4.1.2 As there is insufficient funding for A level programmes of more than 3 A levels to be financially viable, and since Further Mathematics is normally (and rightly) taken as one of four A levels, it is particularly vulnerable.

4.1.3 Over recent years A level qualifications have been extensively reformed. The reforms mean that AS qualifications have been decoupled from A levels and all assessment takes place at the end of the course. Most subjects have already undergone this change. A level Mathematics and Further Mathematics are amongst the last to be changed. The new qualifications are being introduced for first teaching from September 2017 and require a greater emphasis on problem solving, modelling and work with large data sets. There is a serious need for professional development of maths teachers, to ensure the successful implementation of the new qualifications.

4.1.4 Gender inequality and regional inequality in the uptake of the maths A levels are serious concerns.

4.1.5 University STEM departments are often keen to include the mathematics AS and A levels in conditional offers, or to encourage students to take them in their course publicity, but they are frequently overruled by admissions departments who are

14 A level entries fell by 1.65%, from 850749 to 836745 and AS entries fell by 13.7%, from 1196380 to 1385901, source JCQ, August 2016
17 Over the last 10 years the ratios of female to male entries for A level Mathematics and A level Further Mathematics have remained stable at around 40:60 for Mathematics and 30:70 for A level Further Mathematics, source JCQ, http://www.jcq.org.uk/
18 E.g. Nationally, in 2015, 28.6% of A level students took Mathematics; in Norfolk it was only 22.4%, source DfE
Written evidence submitted by MEI (GAP0066)

concerned that such inclusion or encouragement may deter students from applying.

4.1.6 The Extended Project Qualification\(^{19}\) (EPQ) is growing in popularity following explicit recommendation from universities and this appears to be having a negative impact on take up of AS Mathematics and AS Further Mathematics, even though these qualifications would often be far more valuable to STEM students than the EPQ.

4.1.7 Despite the importance of the mathematics AS levels, they carry the same UCAS tariff as all other AS levels. This is lower than the UCAS tariff for an EPQ.

4.2 MEI's work in this area

4.2.1 Since 2005 MEI has managed a government-funded national programme to support A level Further Mathematics, the Further Mathematics Support Programme (FMSP), which currently has an annual budget of £5 million. The FMSP funds a national network of 35 ‘FMSP Area Coordinators’, mostly employed by universities, and an MEI central team.

4.2.2 The FMSP supports schools and colleges nationally to offer the maths AS and A levels, providing professional development for teachers, tuition for Further Mathematics students when schools and colleges cannot provide it themselves; maths enrichment for GCSE students, to encourage more to choose maths post-16, and support for students to take specialist examinations that provide access to degree programmes in mathematics and strongly mathematics related subjects at leading universities.

4.2.3 MEI also provides free access to its extensive teaching and learning resources for Further Mathematics to schools and colleges registered with the FMSP (currently around 3000).

4.2.4 Since 2005, the proportion of state funded schools and colleges with students taking A level Mathematics that also have students taking A level Further Mathematics has risen from 39% to 68% and student numbers for the maths A levels have grown strongly\(^{20}\). A level Mathematics has moved from being the 4th most popular A level subject in terms of entries to being the most popular, and A level Further Mathematics has moved from 27th to 16th.

4.2.5 Working with the A level Content Advisory Board (ALCAB)\(^{21}\) panel for mathematics and with Ofqual\(^{22}\), MEI played a key role in the development of the DfE content documents for the new maths AS/A levels, strongly advocating the greater emphasis on mathematical modelling and on working with large data sets, both of which are crucial for STEM studies.

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\(^{19}\) Extended Project Qualification, [https://en.wikipedia.org/wiki/Extended_Project_Qualification](https://en.wikipedia.org/wiki/Extended_Project_Qualification)


\(^{21}\) A level Content Advisory Board, [https://alcab.org.uk/](https://alcab.org.uk/)

\(^{22}\) Ofqual, [https://www.gov.uk/government/organisations/ofqual](https://www.gov.uk/government/organisations/ofqual)
4.2.6 MEI’s ‘Integral’ online teaching and learning platform is being extensively reviewed and enhanced to address the new A level Mathematics qualifications.

4.2.7 MEI, both through the FMSP and through a Casio-sponsored programme, is offering extensive national professional development to help teachers to prepare for the new A levels in Mathematics and Further Mathematics.

4.2.8 Through its involvement in the leadership of the NCETM, MEI has led the development of support for level 3 maths in the national network of DfE-funded Maths Hubs. The Maths Hubs coordinate with the FMSP and the Core Maths Support Programme to help them to engage with schools and colleges across England, supporting a coherent approach to increasing participation in level 3 maths. In academic year 2016/17, each Maths Hub is expected to spend at least £10 000 on support for level 3 maths.

4.2.9 MEI, through its management of the FMSP, is working to help address gender inequality in uptake of the maths A levels and plans to help address regional inequality, linking with the DfE’s ‘Opportunity Areas’.

4.2.10 Through the FMSP, MEI has done extensive work with university STEM departments and learned societies in STEM disciplines to encourage universities to require or encourage prospective STEM undergraduates to take the maths AS/A levels. STEM academics are often supportive, but they are often unable to influence university admissions policies.

4.2.11 MEI has published a paper to highlight the danger that an unintended consequence of universities’ encouragement of the EPQ seems to be a reduction in the provision of AS level Mathematics and Further Mathematics.

4.3 Recommendations

4.3.1 Funding incentives should be introduced to enable schools and colleges to continue to offer AS and A level Further Mathematics.

4.3.2 Programmes that include AS Mathematics alongside 3 other A levels should receive enhanced funding.

4.3.3 The value of AS Mathematics and AS Further Mathematics as qualifications in their own right should be recognised through an enhanced UCAS tariff.

23 ‘Integral’, https://integralmaths.org/
25 MEI 2017 A Maths level professional development, http://mei.org.uk/2017-pd
26 Maths Hubs, http://www.mathshubs.org.uk/
4.3.4 The work of the FMSP should be continued and expanded to support continued growth in participation in AS and A Level Mathematics and Further Mathematics, including addressing gender and regional inequalities.

4.3.5 Universities should be required to comply with recommendation 1 of the HEA Mathematical Transitions report: *Key stakeholders in academic disciplines within higher education should provide clear signalling to the pre-university sector about the nature and extent of mathematical and statistical knowledge and skills needed in undergraduate degree programmes.*

4.3.6 University STEM departments should consider their policies in relation to the EPQ and, if they consider AS Mathematics and Further Mathematics to be more useful qualifications, they should reflect this in their entry requirements and their advice to students.

5. Core Maths qualifications

5.1 Current situation

5.1.1 The DfE funded the Core Maths Support Programme[^31] (CMSP) to support the implementation of Core Maths, and funded early-adopter schools to introduce it. The CMSP has established a national network of Core Maths Leads. As things currently stand, this support will end in July 2017.

5.1.2 Core Maths was examined for the first time in 2016 and a little under 3000 students took the examination nationally.

5.1.3 Teachers and students in many of the early adopter schools and colleges have found Core Maths a useful and worthwhile course.[^32]

5.1.4 Schools and colleges that offer Core Maths receive no additional funding. This means that many that would like to offer the course are unable to do so.

5.1.5 The shortage of teachers able to teach maths at this level means some schools and colleges feel they could not offer Core Maths even if it were funded.

5.1.6 The EPQ threatens uptake of Core Maths at least as much as it threatens the maths AS levels (see 4.1.6).

5.2 MEI’s work in this area

5.2.1 MEI was instrumental in conceiving Core Maths and was funded by the DfE (£275 000 over 3 years) to develop a ‘Critical Maths’ curriculum[^33], which was shared with all of the examination awarding bodies to help inform the development of their Core Maths specifications.

[^33]: Critical Maths: A mathematics-based thinking curriculum for level 3, [http://mei.org.uk/l3_probsolv](http://mei.org.uk/l3_probsolv)
5.2.2 As mentioned in 4.2.6 above, MEI helps to support Core Maths through its leadership role with the NCETM and the work of the Maths Hubs.

5.2.3 MEI provides extensive online resources to support the teaching and learning of Core Maths free of charge on its website.\(^{34}\)

5.2.4 MEI offers highly regarded professional development for Core Maths teachers.\(^{35}\)

5.2.5 As explained in 4.3.6, MEI has published a paper drawing attention to the threat to level 3 maths from the EPQ.

5.3 Recommendations

5.3.1 Core Maths should be made compulsory for all students who have achieved a level 2 pass in GCSE Mathematics and are not following any other post-16 level 3 maths pathway.

5.3.2 If Core Maths is to fulfil its considerable potential, schools and colleges must be funded to offer it.

5.3.3 A national programme of support for Core Maths should continue until participation passes 100 000 students per annum, by which time it could be said to be properly established.

5.3.4 Teachers of STEM subjects and other numerate disciplines post-16 should be expected to teach Core Maths, and funding should be made available for such teachers to receive professional development to enable them to teach Core maths effectively.

5.3.5 University STEM departments should consider their policies in relation to the EPQ and, if they consider Core Maths to be a more useful qualification, they should reflect this in their entry requirements and their advice to students.

6. GCSE re-sit

6.1 Current situation

6.1.1 The re-sit policy explained in 3.1.6 is not working. In 2016 around 174 000 students re-sat GCSE mathematics, but only 29.5% achieved a level 2 pass.\(^{36}\) This is turning students off maths and damaging the image of maths and of all STEM studies.

6.1.2 Further Education colleges have insufficient qualified staff to teach the huge numbers of GCSE re-sit students.

6.1.3 GCSE Mathematics resit is not the best option for many who are entered for it.\(^{37}\)

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\(^{34}\) Core Maths resources, [http://mei.org.uk/iqm-resources](http://mei.org.uk/iqm-resources)

\(^{35}\) Professional development for Core maths teachers, [http://mei.org.uk/core-maths-cpd](http://mei.org.uk/core-maths-cpd)

6.2 MEI’s work in this area

6.2.1 MEI has published a position paper on the new GCSE Mathematics\footnote{MEI position paper on the 2015 reform of GCSE Mathematics, June 2016, \url{http://mei.org.uk/files/pdf/MEI-2015-GCSE-Mathematics-reform-position-paper-revised-160616.pdf}} which highlights the issues with the GCSE resit and recommends how they could be addressed.

6.3 Recommendations

6.3.1 A new post-16 GCSE Mathematics course should be developed, as described in MEI’s position paper referenced in 6.2.1.

6.3.2 A substantial, sustained programme of teacher recruitment and professional development should be established for maths teachers in Further Education colleges.

6.3.3 The pay and conditions of teachers working in Further Education should be on a par with those in working in schools.

7. Conclusion

7.1 The recommendations above would help close the STEM skills gap by helping to ensure that young people could access the maths education needed to support a future career in STEM.

7.2 The level 3 maths pathways and recent curriculum reforms in mathematics have the potential to really improve maths education in the UK.

7.3 However, sufficient funding to support the changes is vital. There is considerable need for professional development for post-16 maths teachers, but engagement is low because schools and colleges cannot meet the cost.

7.4 There are worrying indications that without more support Core Maths will not become established, so our levels of participation in post-16 maths will remain woefully low.

7.5 There is also a strong possibility that AS and A level Further Mathematics numbers in state-funded schools and colleges will fall dramatically.

8.1 Maths education is at a crossroads; much good work has been done that could be built upon with sufficient, continuing investment. Without such investment the recent curriculum changes could prove counter-productive and the progress made over recent years could be reversed, widening the STEM skills gap.

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\footnote{FE Week, September 2016, \url{http://feweek.co.uk/2016/09/11/gcses-vs-functional-skills-which-english-and-maths-resits-should-your-students-take/}}