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Mathematics in Further Education Colleges

Final Report – executive summary

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Foreword

Mathematics is of central importance to modern society. Our young people therefore need a high quality mathematics education that develops both the *competence* to use appropriate mathematics in a variety of work, learning and life contexts, and the *confidence* with which to do so. Addressing the negative attitudes to learning mathematics that I highlighted in my report to the Treasury in 2017 is key, no more so than for the students in our further education colleges. Improving the quantitative skills of this group, many of whom follow vocational and technical pathways into key employment sectors, is critical for national prosperity and to narrowing the opportunity gaps in our nation.

Many reports have called for improvements in mathematics education and often these centre on learners following academic pathways. This comprehensive study delves into the complex challenges facing managers, teachers and students in England's further education sector. The authors have thoroughly investigated how the various components of the mathematics education system interact in colleges and have made a series of clear recommendations for key stakeholders.

The Inquiry into Post-14 Mathematics Education that I chaired over 15 years ago identified shortcomings in 1) the curriculum and qualifications framework, 2) the supply of teachers and 3) the continuing professional development architecture. Whilst there has been some progress made in these areas for schools, the further education sector has remained something of a black box, until now. As we navigate our way through uncertain times, repositioning our economy post-Brexit and responding to Covid-19, this is a key moment to push for a better mathematics education for these young people.

The authors highlight that much more needs to be done to address the aforementioned three challenges in the FE sector. There is an outstanding need to develop a coherent and sustainable suite of appropriate mathematics pathways to support vocational and technical employment routes. Similarly, teacher supply, initial training and career-long CPD need to be improved and there is a clear need for leadership development. The report suggests that some of this can be achieved by harnessing and coordinating the energy and expertise within the sector, but there is also need for further investment in leadership, recruitment and CPD.

This report offers much needed insight for those with limited experience of our FE sector so that better interventions can be designed to address the seemingly intractable shortcomings in the nation's quantitative skills base. The study takes seriously the complexity of organisational and sectoral change and I hope that the findings and recommendations will both challenge and support those tasked with improving the mathematical competence and confidence of our young people.

Professor Sir Adrian Smith FRS

Director of The Alan Turing Institute

Executive summary

Mathematical skills are key to the future prosperity and wellbeing of individuals and society. Yet concerns about adult numeracy raised at the end of the last century in the Moser Report[1] have not abated[2] and international comparisons continue to highlight England's weak quantitative skills base[3]. In the last decade, the Wolf Report[4], Sainsbury Review[5] and UK Industrial Strategy[6] have all reinforced the need to improve the nation's mathematical competence. Achieving such improvement, however, is a *wicked problem*.

Smith's (2017) review of post-16 mathematics[7] expressed "the need to recognise more explicitly…the fundamental importance of Further Education in the post-16 landscape". The current Centres for Excellence in Mathematics programme is one aspect of the government's strategic response to that report and the forthcoming Further Education (FE) White Paper will hopefully bring renewed attention to mathematical learning as a necessary element of reforms to vocational and technical education.

The new Condition of Funding, first introduced in 2014, required many more post-16 students without a GCSE grade C/4 to continue their study of mathematics. For those previously awarded a grade D/3, retaking GCSE is now the only option although those with lower grades may take a Functional Skills qualification as a 'stepping stone' to GCSE. This policy produced an initial increase in mathematics participation and progress, which national published data suggest has stalled thereafter. The Condition of Funding also precipitated considerable changes to the mathematics teacher workforce and to the management and organisation of mathematics in General Further Education Colleges (GFECs)[8].

Students with low GCSE attainment in mathematics (and English) have been termed 'the forgotten third'[9] and the majority of them proceed to vocational programmes in FE post-16. Analysis of retake students' mathematics progress in 2015/16 highlighted relatively poor progress for those in FE colleges[10]. Less than a quarter of students without a GCSE grade 4 in mathematics at age 16 achieve this by age 18.

Continued investment is therefore needed to improve mathematics outcomes for these students and this report proposes a number of priority areas for action. A long-term strategy for the development and continual improvement of appropriate qualifications and learning experiences is required. This is in contrast to the regular changes in

[1] Moser, S. C. (1999). *Improving literacy and numeracy: a fresh start*. London: DfEE Publications.
[2] National Numeracy (2019) Building a numerate nation: confidence, belief and skills. NN: London
[3] OECD (2016), Skills Matter: Further Results from the Survey of Adult Skills, OECD Skills Studies, OECD Publishing, Paris
[4] Wolf, A. (2011). Review of vocational education. London, Department for Education.
[5] Sainsbury, D. (2016). Report of the Independent Panel on Technical Education. DfE/BIS. London.
[6] BEIS (2017). Industrial Strategy: building a Britain fit for the future. Department for Business. London, HMSO
[7] Smith, A. (2017). "Report of Professor Sir Adrian Smith's review of post-16 mathematics." London: DfE.
[8] The project centres on General Further Education Colleges (GFECs) since these are the main providers of further education in England with 174 GFECs out of a total of 257 FE colleges (February 2019). For simplicity, we sometimes omit 'general' and refer to these as FE colleges in the report
[9] ASCL (2019). The Forgotten Third: final report of the commission of inquiry. Oxford, Association of School and College Leaders.
[10] Rodeiro, C. V. (2018). "Which students benefit from retaking Mathematics and English GCSEs post-16?" Research Matters (25): 20-28.

(mathematics) qualifications since the Moser Report that evidence an academic drift through core skills, key skills and functional skills to GCSE[11].

In this context of complexity and change, the Mathematics in Further Education Colleges project set out an ambitious research agenda designed to understand the mathematics education landscape in FE; the processes of policy enactment in colleges; the challenge of recruiting, developing and organising the workforce; and colleges' operational strategies and students' experiences. The focus was on the student cohort retaking GCSE Mathematics and vocational students in particular, since these comprise the largest part of mathematics provision in colleges.

The MiFEC project (2017-20) aimed to bridge from the national scale through college provision to classroom experience. The multiscale research design assumed that more effective change and implementation planning is contingent upon systems thinking and coordinated action. The project comprised four work packages:

Work Package 1: Review of literatures and twenty year policy analysis

Work Package 2: Analysis of national administrative datasets

Work Package 3: Case studies of General Further Education Colleges

Work Package 4: National survey of the FE mathematics teacher workforce

The case studies engaged around one sixth of England's GFECs at the time the project commenced[12]. In total the field work involved 44 site visits, including 238 interviews with staff and 62 focus groups involving 388 students. There were 480 survey respondents from the sample colleges, a response rate of over 60%.

A series of Interim Reports[13] and academic papers have been published from the project to date. This Final Report synthesises the findings from the four work packages into six themes. Our recommendation are made with four groups in mind (national policymakers, senior leaders in colleges, mathematics curriculum leaders and other stakeholders) but we refrain from linking any particular recommendation to a group.

Appreciating context and ensuring equality of opportunity

A college's local context and its general curriculum offer influence both the size and the motivations of the mathematics student cohort. Mathematics performance models would be fairer if such contextual factors were taken into account. Colleges' prioritisation of learner needs and/or different progress measures influence strategic decisions about students' mathematics pathways. Similar students in different colleges do not therefore get the same opportunities. Changes to measures of progress may lead to greater consistency between colleges and more equitable learning experiences for students.

> **Recommendation 1:** Consideration should be given to adding contextual factors into models of mathematics progress to more fairly reflect the achievements of students and colleges.

[11] Dalby, D. & Noyes A. (2020). Mathematics curriculum waves within vocational education, Submitted for review to Oxford Review of Education

[12] Other FE colleges (e.g. Sixth Form Colleges, specialist colleges) may identify with some of the issues raised but the size of provision and organisational complexity of large GFECs means this has been the main focus of this study. Where we use FE Colleges, it refers to GFECs

[13] MiFEC reports are available at www.nottingham.ac.uk/research/groups/crme/projects/mifec/index.aspx

Recommendation 2: The learning goals and preferred qualifications pathways for students entering FE with GCSE grades 1 and 2 should be agreed, with performance measures being revised to support these objectives.

Understanding and developing leaders, systems and processes

Cross-college leadership and management is challenging due to the dispersion of students across sites and the shared responsibilities with vocational staff. Bespoke training is needed to enable cross-college managers to make well-informed decisions on strategic and operational approaches. Colleges benefit from mathematics being an institutional priority, with well-defined sharing of responsibility and good collaboration between those with leadership responsibilities for mathematics at different levels. Operational challenges are complex in large colleges. Approaches to timetabling, induction, staffing and attendance monitoring that are sensitive to the particular needs of these mathematics students helps to produce classroom experiences that are more conducive to learning.

Recommendation 3: A new national programme of leadership training should be developed appropriate for those in cross-college mathematics leadership positions to include strands on 1) curriculum leadership, 2) organisational strategy, 3) systems management, and 4) reflective and evaluative change leadership.

Recommendation 4: A mathematics self-evaluation toolkit and support package should be designed to aid college managers in reviewing their organisational strategies and developing improvement plans appropriate to their local context.

Recommendation 5: Operational planning (e.g. timetabling, attendance) in some colleges needs to take better account of the GCSE retake students' characteristics in order to provide the best possible environment for learning.

Establishing a distinctive FE mathematics teacher workforce

Mathematics teachers[14] in colleges come from a range of backgrounds with different subject and teaching qualifications. The workforce had to expand due to the increased numbers of students retaking mathematics following the Condition of Funding, albeit amidst ongoing national teacher shortages. The deregulation in the FE sector has allowed colleges to make independent judgements about appropriate qualifications and training for their staff. Entrepreneurial approaches to teacher recruitment have been developed by colleges but more support is needed nationally to boost recruitment and to provide appropriate training for those entering FE mathematics teaching through a variety of routes.

Recommendation 6: A national recruitment campaign to attract career-changers from diverse backgrounds should be designed and launched with some urgency.

Recommendation 7: Initial training requirements for teaching mathematics in FE should be reviewed and a national training strategy developed that distinguishes between the needs of teachers who are undergoing 1) a significant *career* change, 2) a change of *curriculum* focus, and 3) a change of educational *context* (e.g. from school to FE)**.**

[14] In this study we refer to mathematics teachers as those teaching courses that lead to a mathematics qualification. Mathematics is also taught by other teachers (e.g. vocational teachers) in embedded and modular forms within other courses.

Developing the existing FE mathematics teaching profession

Few mathematics teachers in FE undertake full-time training prior to entering the workforce so professional development is particularly important. There are wide variations in the amount, type and quality of mathematics-specific CPD accessed by teachers. Colleges would benefit from clearer guidance on what 'professionalism' in FE mathematics teaching means and a framework of professional standards to guide teacher development. Diverse entry routes and teacher backgrounds add to the complexity of providing appropriate professional development for all. Training needs analysis tools, longer-term professional development planning and better understanding of effective CPD are needed so that colleges can make good use of effective models, including college-based opportunities to develop professional learning communities and practitioner research.

Recommendation 8: Designated funding should be ring-fenced for the professional development of mathematics teachers in FE colleges.

Recommendation 9: An individual entitlement to high-quality, mathematics-specific continuing professional development should be defined and adopted nationally.

Recommendation 10: Sector agreement on appropriate professional standards for mathematics teachers in the FE sector needs to be established as a framework for professional development.

Recommendation 11: Tools for conducting training needs analysis should be developed to support long-term professional development planning for mathematics teachers and teaching teams.

Recommendation 12: Guidance on effective CPD models, such as the development of professional learning communities and practitioner research, should be provided in order to build capacity in the workforce for sustainable self-improvement.

Recommendation 13: The initial and ongoing training of vocational teachers[15] should include better opportunities to develop personal confidence with mathematics.

Understanding and developing pedagogy in context

Teachers' choices of classroom approaches are contingent upon a range of contextual, organisational and educational factors. Teachers and students are largely in agreement about the teaching and learning approaches that work best in the FE context. Most students view their learning experiences more positively than those in school, although they would like even greater use of student-centred approaches[16]. Teachers identified the need to counter low levels of student motivation and engagement and to adapt teaching in multiple ways to meet students' needs. This contingent teaching requires a rich toolkit of strategies and resources, and this in turn demands a sustained programme of teacher professional development. There are variations in the provision and uptake of out-of-class learning opportunities for students, and in the embedding of mathematics into vocational

[15] Vocational teachers are considered here to be those who teach solely on vocational study programmes and do not teach mathematics qualifications.
[16] A categorisation of student-centred and teacher-centred approaches was used based on that developed by Malcolm Swan (2006).

learning which require further research to ensure colleges can supplement and support classroom teaching in the most effective ways.

Recommendation 14: Teaching and learning approaches that address the specific contexts, constraints and affective issues in FE need to be researched, developed and widely disseminated across the sector.

Recommendation 15: Mathematics teachers in FE need ongoing support and professional development to develop rich pedagogical toolkits that enable them to adapt teaching and learning to meet diverse students' needs.

Recommendation 16: More effective strategies for out-of-class mathematics learning for FE students needs to be developed, evaluated and disseminated.

Recommendation 17: Research on approaches to the 'embedding' of mathematics into vocational learning and the impact of different practices needs to be commissioned[17].

Objectives, pathways and sustainable improvement

Analysis of FE mathematics policy over the last 20 years shows how repeated attempts to develop alternatives to GCSE mathematics (i.e. core, key and functional skills) have failed to produce a sustainable and trusted qualification that addresses the skills needs of vocational learners. Now is an opportune time for a renewed attempt to establish post-16 mathematics pathways for different academic, vocational and technical tracks and to map the full mathematics learning opportunities across programmes. Future policy design and implementation needs 1) greater involvement from the FE sector, 2) more realistic timescales, and 3) careful consideration of unintended consequences. The design of sustainable, trusted qualifications for vocational learners that can stand the test of time (c.f. GCSE) is needed.

Recommendation 18: The long-term policy objectives for post-16 mathematics education need clear articulation. This might include:

- renewed effort to establish a pathways model for 14-18 mathematics that complements different academic, vocational and technical routes[18];
- identification of recommended qualification pathways for students with particular prior attainment and mathematical learning needs;
- a mapping of post-16 mathematics learning opportunities both in stand-alone qualifications and embedded within courses and programmes.

Recommendation 19: Future developments in post-16 FE mathematics require:

- a long-term commitment to design, development, piloting and improvement in order to build trusted qualifications and break the pattern of qualification devaluation;

[17] The General Mathematical Competencies framework designed by the RS/ACME and adopted into the T-level framework offer one line of approach that might have wider applicability for vocational programmes.
[18] For commentary on the metaphor of 'stepping stone' qualifications see Dalby, D. & Noyes, A. (2020). The waxing and waning of Functional Skills mathematics. Journal of Vocational Education and Training. https://doi.org/10.1080/13636820.2020.1772856

- a realistic timescale and planning process[19] including consideration of staffing, training and CPD, qualification and resource development;
- consideration of potential unintended consequences;
- closer collaboration with the sector during development and implementation phases.

Recommendation 20: A broader set of performance indicators should be considered for post-16 mathematics education, for example confidence and self-efficacy, in order to stimulate policy and practice that better addresses the national challenge of improving quantitative skills.

[19] The Royal Society/Advisory Committee on Mathematics Education's ongoing work to develop a Qualifications Assessment Framework could inform such design processes.