Universities as a driver of A level uptake: The case of Maths and Further Maths

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We are at a crossroads. New, harder, GCSE Mathematics qualifications were taken for the first time in Summer 2017 and that cohort of students are now studying the all new linear (rather than modular) Mathematics A levels. There is already suggestion from teachers that numbers starting Mathematics and Further Mathematics A levels may have reduced. This paper reports on three different analyses, which highlight just what an important role universities can play in helping to maintain entry numbers to A level Mathematics and Further Mathematics during this time of considerable change. The areas explored include:

- A review of recent data on entries to Mathematics A level qualifications
- Analysis of unpublished UCAS data to show at which universities and in which subject areas students with Mathematics A levels go on to study
- Analysis of entry requirements from over 750 degree courses to establish what prior maths qualifications they require

Keywords: A level; university; entrance requirements

Background – Changes to 14-18 curriculum and post-16 funding

In England the majority of students (~600 000) take exams for a General Certificate in Secondary Education (GCSE) at aged 16. Around 450 000 students then continue study in further education for vocational or academic qualifications, with around 325 000 studying for A levels (source: DfE tables SRF59/2017).

New GCSE Mathematics qualifications were introduced for first teaching in 2015. This cohort of students is to be the first to be taught reformed A level qualifications from September 2017. Around the same time changes were made to the funding of post-16 qualifications. These new funding arrangements (see: www.gov.uk/guidance/16-to-19-funding-how-it-works) now base funding on the number of students following a full programme of study (approximately 600 hours) and no longer on the number of subjects taken.

One of the reforms to A level qualifications is to decouple the AS and A level qualifications. Hence grades/marks achieved for AS level no longer count towards the A level grade. Glaister (2017) provides a detailed account of the changes to Mathematics A levels, whilst a more wide-ranging overview of pre-university maths qualifications can be seen in Lee (2016).

These collective changes could have a significant impact on the provision for and uptake of Mathematics A levels. This paper will therefore look at participation in Mathematics A levels before considering current research and reports in the area. Overarching analysis of Universities and Colleges Admissions Service (UCAS) data on the undergraduate subjects by students with Mathematics A levels is presented.

This leads on to analysis of entry requirements from over 750 degree courses to establish what prior maths qualifications they require. Finally, a wider discussion is made as to the part universities can play in maintaining the uptake of Mathematics A levels.

Participation in Mathematics A levels…has been increasing

In summer 2017 nearly 88 000 students entered for A level Mathematics in England, an increase of 83% since 2004 (source: Joint Council for Qualifications (JCQ)). The year 2004 was chosen as it was the first year Mathematics / Further Mathematics numbers were separated in the reporting by JCQ and represented the post-2000 Mathematics specifications that have largely been carried over until 2017. Additionally, it is noteworthy that for the last 4 years Mathematics has had the highest number of entries of any A level subject, surpassing English.

In A level Further Mathematics – an additional A level subject which aims to broaden and deepen students' knowledge – there have been even more impressive percentage rises in entry. In summer 2017 entries in England peaked at over 15 000, thus almost tripling in number from just over 5 000 in 2004. It is now the 16th most studied A level, ahead of subjects such as Design and Technology, Law and Computing.

Male students are much more likely than female students to take Mathematics and Further Mathematics A levels. However, equality is not present in the uptake of many A level subjects and though there is a 23% swing for males in Further Mathematics, there is an equivalent swing for females in English (source: JCQ). A useful investigation 'Closing doors: Exploring gender and subject choice in schools' was conducted by the Institute of Physics (2013) and included progression to A levels.

Current research and reports

Of particular relevance in this area of work is a 3-year study (2013 to 2016) into 'Rethinking the value of Advanced Mathematics Participation' that has been conducted by Prof Andrew Noyes (Nottingham University) through a Nuffield Foundation grant (EDU/41221). Strands of the project included:

- Updated research on the 'economic return' to A level Mathematics
- An investigation of the nature of changing participation in A level Mathematics from 2005-13
- A large-scale survey of 17-year-olds

A final report has been produced (Noyes and Adkins, 2017) and gives a thorough and timely account of the state of attitudes to, and participation in, advanced mathematics prior to the introduction of the reformatted 2017 Mathematics A levels.

An eagerly anticipated independent review of post-16 maths by Prof Sir Adrian Smith was published in summer (Smith, 2017). It has been welcomed by the wider maths community with considerable support for the recommendations it made.

Kewin and Donhowe (2017) from the Sixth Form Colleges Association have produced one of the most up-to-date reviews of the effects of the changes to post-16 funding in their November 2017 'Funding impact survey report'. This follows on from an earlier report in the year into the provision of qualifications by UCAS (2017). The former cited that over a third of schools and colleges (34%) have dropped STEM (Science, Technology, Engineering, Mathematics) A level courses and that two thirds of schools and colleges (66%) have moved from a four A level subject offer as

standard to a three subject offer, thus supporting the UCAS finding that 56% of respondents have changed their A level provision since the 2015/16 academic year.

Lord and Lee (2017) discussed a number of similar themes to this paper in the proceedings of the Mathematics Education beyond 16: Pathways and Transitions Conference. This included analysis of patterns of entry for students taking three A level subjects or more, which affects Further Mathematics in particular, as well as historical analysis (from years 2005/2013/2016) of which undergraduate subject groups those with Further Mathematics went on to study. This is an area will be considered more widely in respect to Mathematics A levels in the next section of this paper.

Universities that accepted the most undergraduates with Mathematics A levels

Mathematics in Education and Industry (MEI) sourced a dataset directly from UCAS relating to students entering university in 2016/17. The data included a breakdown by university, by degree subject group and by degree subject line of those who were accepted that had obtained Mathematics A level qualifications. This section, and its sub-sections, will provide insight into these three breakdowns.

Firstly, considering each university as a whole – overall, 22 universities accepted more than 1000 students with A Level Mathematics (39 accepted more than 500). Similarly, there were 28 universities that accepted more than 100 students with A Level Further Mathematics. Table I shows the top five universities for these.

Provider Name (2016/17)	**No. of acceptances (Mathematics)**		**Provider Name (2016/17)**	**No. of acceptances (Further Mathematics)**
The University of Nottingham	2120		University of Cambridge	780
University of Bristol	1755		The University of Warwick	730
The University of Sheffield	1700		University of Bath	640
The University of Birmingham	1655		Oxford University	595
The University of Manchester	1655		Durham University	560

Table I – Top five universities who accepted students with Mathematics A level, and Further Mathematics A level 2016/17.

Though no further analysis has been undertaken at a University wide level, it is anticipated that the selection of course types available at these universities (i.e. STEM vs Arts etc.) plays a large part in the number of accepted students with Mathematics A levels. More specifically in respect to Further Mathematics – the five universities listed do stand out as being known to have some of the top rated maths degrees across England, with many requiring additional 'maths-specific' tests to gain entry (e.g. Sixth Term Entry Papers (STEP), Mathematics Admission Test (MAT) and the Test of Mathematics for University Admission (TMUA) – see: www.furthermaths.org.uk/maths_degrees).

University undergraduate subject group level analysis

The next level of detail over a university wide analysis is of 'subject group'. Table II shows the top five subject groups (across all universities) that have students accepted with A level Mathematics, and separately, A level Further Mathematics.

From the number of acceptances with A level Mathematics it is clear that the qualification is being seen as an entry requirement more so for 'other' subject groups, than directly for the collective Mathematical Sciences group of qualifications. Whereas the main 'recipients' of students that have A level Further Mathematics is the Mathematical Sciences. However, from the wider analysis (and also seen in this top 5 list), Mathematics A levels are being seen as an entry requirement across the spectrum of university Subject Groups.

Subject Group Summary Level	**No. of acceptances (A level Mathematics)**		**Subject Group Summary Level**	**No. of acceptances (A level Further Mathematics)**
Group H Engineering	9290		Group G Mathematical Sciences	3435
Group F Physical Sciences	6470		Group H Engineering	2370
Group G Mathematical Sciences	5330		Group F Physical Sciences	1420
Group C Biological Sciences	4725		Group I Computer Sciences	830
Group L Social Studies	4465		Group L Social Studies	530

Table II – Top five university subject groups who accepted students with Mathematics A level, and Further Mathematics A level 2016/17.

University undergraduate detailed subject group level analysis

The 129 degree subject lines, as classified by UCAS, were reviewed in respect to how many students were accepted onto a degree having studied A level Mathematics, and how many had studied A level Further Mathematics. Table III shows the top ten.

Subject Group Detailed Level	**No. of acceptances (A level Mathematics)**		**Subject Group Detailed Level**	**No. of acceptances (A level Further Mathematics)**
G1 – Mathematics	5065		G1 – Mathematics	3290
L1 – Economics	3085		F3 – Physics	1060
H3 - Mechanical Engineering	2760		H3 – Mechanical Engineering	765
F3 - Physics	2715		I1 – Computer Science	765
I1 – Computer Science	2715		H1 – General Engineering	525
A1 – Pre-clinical Medicine	2700		Z – Combinations of 3 subjects	525
F1 – Chemistry	2195		L1 – Economics	480
Z – Combinations of 3 subjects	1590		A4 – Aerospace Engineering	345
H8 – Chemical, Process and Energy Engineering	1495		H8 – Chemical, Process and Energy Engineering	260
H1 – General Engineering	1420		F1 – Chemistry	240

Table III – Top ten university subject lines who accepted students with Mathematics A level, and Further Mathematics A level 2016/17.

Whilst it is obvious that many of those with Mathematics A levels go on to study G1 Mathematics degrees, it's also interesting to observe the high numbers who go on to study Economics, Mechanical Engineering, Physics, Computer Science and Pre-clinical Medicine. It is fascinating to see that those entering for similar degrees were also those that had the most students who have also studied A level Further Mathematics (more analysis of the previous year's dataset in this respect can be seen in Lord and Lee, 2017). It was explicit in this detailed subject line review how Mathematics A levels are being used for entry across an extensive range of courses.

Universities entry requirements in relation to Mathematics A levels

Analysis of entry requirements and statements from over 750 degree courses to establish what prior maths qualifications they require for entry in 2018 was undertaken in October 2017. Table IV shows this summarised for STEM and STEM-related subjects against those who required and preferred A level Mathematics, and separately, those who required and preferred A level Further Mathematics.

Degree Course	**No. of courses reviewed**	**% A level Mathematics required**	**% A level Mathematics preferred or encouraged**	**% A level Further Mathematics required**	**% A level Further Mathematics preferred or encouraged**
Mathematics G1	67	100%	0%	12%	19%
Physics F3	43	100%	0%	0%	12%
Aeronautical Engineering H4	28	96%	0%	0%	14%
Chemical Engineering H8	25	96%	0%	8%	8%
Mechanical Engineering H3	68	96%	3%	0%	7%
Electrical Engineering H6	59	88%	8%	0%	8%
Civil Engineering H2	53	89%	8%	0%	2%
Computer Science G4	89	26%	9%	1%	4%
Chemistry F1	51	14%	2%	0%	0%
Biology C1	62	0%	2%	0%	0%
Economics L1	69	25%	1%	0%	1%
Geography F8	55	0%	0%	0%	0%
Psychology C8	88	0%	0%	0%	0%
All courses surveyed	***757***	***56%***	***3%***	***2%***	***6%***

Table IV – Entry requirements of degree courses

Whilst it is clear that the majority of university STEM subjects currently require A level Mathematics, very few are even indicating encouragement or preference for A level Further Mathematics. This observation will be considered in the discussion of the wider picture in the section that follows.

Wider picture – universities as a key driver to maintaining uptake

Change is taking place. Change in curriculum, change in examinations, change in funding. The research from Kewin and Donhowe (2017) and Lord and Lee (2017) suggests there is real danger that numbers studying Mathematics A levels could reduce dramatically. This at a time when higher mathematical skills are widely valued

(Noyes and Adkins, 2017). Consequences could include minimum class sizes for viable groups increasing, schools/colleges reducing the number of A levels offered, schools/colleges beginning to stop offering AS levels, students taking only 3 A levels from Year 12 rather than starting with 4 AS levels, and Further Mathematics (most often taken as a 4th option) potentially seeing lower entry numbers.

From considering analysis of the degrees students commenced having studied Mathematics A levels (Tables I/II/II) and what university requirements are in this respect (Table IV), it is obvious the crucial part universities play in what students consider for study at A level. Notwithstanding a £19.5 million Q-Step programme designed to promote a step-change in quantitative social science training via universities in the UK, it is clear that a supply of those with suitable pre-university Mathematics qualifications could be in danger. It is suggested that where possible universities provide a clear, strong message about the importance and usefulness of studying AS/A level Mathematics/Further Mathematics. Such action will also provide evidence to support teachers in recruiting and persuading students to choose the subject. This was a key recommendation (#4) from the Smith Review (2017):

> …to encourage universities to better signal and recognise the value of level 3 mathematics qualifications for entry to undergraduate courses with a significant quantitative element.

Conclusion

This is a very import moment in time. Numbers studying Mathematics A levels could reduce dramatically in the coming few years. It is crucial for direction to be given to students and teachers as to the value of 16-18 Mathematics qualifications. Universities can use their information, advice and guidance to prospective students to make positive statements and give encouragement for the study of suitable maths courses pre-university to create a necessary 'pull' incentive.

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