Student progression to STEM degrees – who has studied A level Further Mathematics?

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Abstract

There was a catastrophic fall in the number of students studying A level Mathematics in the early 2000s. It is generally thought that this was due to the introduction of a new A level curriculum structure. The numbers studying the second A level in mathematics, Further Mathematics, also dropped dramatically. However, following changes to the mathematics A level specifications in 2004, and the implementation of several large scale curriculum projects, the numbers studying mathematics A levels have risen to well beyond their 2000 levels. The most dramatic rises, in percentage terms, have been in A level Further Mathematics and have been attributed largely to the work of the Further Mathematics Support Programme (formerly the Further Mathematics Network), a project funded by the Department for Education (DfE) and managed by the educational charity Mathematics in Education and Industry (MEI).

Concern continues to prevail in universities regarding the poor mathematical skills of some students embarking on STEM undergraduate courses. This paper considers progression data that indicate which degree subjects the increasing pool of students with A level Further Mathematics (AL FM) is going on to study at university. It also gives suggestions for how university departments might attract more mathematically-prepared students by using their entry requirement statements to encourage the study of AS/A level Further Mathematics.

Keywords
A-level, further, mathematics, statistics

1. Introduction

In the year 2000 a new A level curriculum structure was brought into effect in England, known as Curriculum 2000. The issues surrounding this implementation are well documented; see for example Matthews and Pepper (2006). Porkess (2006) quoted figures for those studying A level Mathematics as falling from 71000 in 1998 to 54000 in 2002. He highlighted a similar drop in AL FM numbers to only 5000 in 2005. As the damage had been so great, a revised Mathematics (and Further Mathematics) curriculum was devised and

introduced for first teaching in 2004. QCA (2007) reported on the new curricula and indicated evidence of better retention and recruitment rates.

In the last decade a number of large-scale projects have acted to promote and support post-16 mathematics and other STEM subjects. Searle (2010, 2011) in his papers *Saving Further Mathematics* and *Investigating the impact of the Further Mathematics Network*[1] discussed the part the Further Mathematics Support Programme (FMSP) has played in increasing the numbers studying Further Mathematics. AL FM numbers reached more than 13 000 in 2012, an increase of 160% since 2005. As well as providing access to teaching and learning resources and tuition, the FMSP also provides extensive opportunities for student enrichment and teacher professional development. These areas of work seek to further develop student interest in studying further mathematics and to provide support to those teaching such mathematics.

Those who study Further Mathematics are exposed to additional, interesting and useful material that complements and extends their A level Mathematics studies. Extra material, such as complex numbers, matrices, statistical testing, can be very useful for those making the transition from school/college onto various STEM degree programmes.

2. Progression data

MEI purchased a dataset[2] for those entering university in the academic year 2010/11 and the five previous years. With these data it was possible to analyse the proportion of students with AL FM entering different degree subjects.

2.1 G1 Mathematics degree courses

The first part of the analysis considers specifically the G1 Mathematics courses (as described by the JACS2 subject line).

University Academic Year	Total number of students accepted onto degree course (1)	Total number of students accepted to G1Mathematics courses **who studied A Levels** (2)	Total number of students accepted to G1 Mathematics courses **who studied A Level (A2) Further Mathematics** (3)	Percentage of those accepted to G1 Mathematics courses **who studied A levels that studied A Level (A2) Further Mathematics** (4)
2005/06	5041	4217	1503	35.6%
2006/07	5349	4465	1756	39.3%
2007/08	5861	4799	1935	40.3%
2008/09	6403	5591	2250	40.2%
2009/10	6916	6096	2454	40.3%
2010/11	7276	6651	2855	42.9%

Figure 1 – Number of accepts on G1 Mathematics courses

[1] The Further Mathematics Network was the predecessor to the FMSP running from 2003 to 2008.
[2] The dataset was sourced from UCAS.

Figure 1 shows the total number of students accepted onto G1 Mathematics courses (1), those who studied A Levels (2), as well as the total number of students accepted to G1 Mathematics courses who studied AL FM (3) and, finally, the percentage of those accepted onto G1 Mathematics courses who studied A levels that have also studied AL FM (4), i.e. (3) as a percentage of (2).

The numbers of students in (1), (2) and (3) have all risen between 2005/06 and 2010/11 (by 44%, 58% and 90% respectively). This is excellent news as it means more students are studying Mathematics at university and that more are entering having studied AL FM. Furthermore, the percentage of those accepted onto G1 Mathematics courses who have studied A levels and who also have AL FM, has increased from 35.6% in 2005/06 to 42.9% in 2010/11.

2.2 STEM and other degree courses in 2010/11

Subject line code and name classification		Total number of students accepted onto degree course	Total number of students accepted onto course **who studied A Levels**	Total number of students accepted onto course **who studied A Level (A2) Further Mathematics**	Percentage of those accepted onto course **who studied A levels that studied A Level (A2) Further Mathematics** (*2005/06 figure*)
G0	Mathematical & Comp Sci: any area	107	83	61	73.5% (61.5%)
G1	Mathematics	7276	6651	2855	42.9% (35.6%)
H1	General Engineering	3237	1836	650	35.4% (8.8%)
G3	Statistics	147	123	39	31.7% (34.1%)
GG	Combinations within Mathematical & Computer Sci	2203	1097	235	21.4% (17.9%)
F3	Physics	3672	3055	645	21.1% (15.7%)
N3	Finance	1687	660	129	19.5% (7.3%)
Y	Combs of phys/math sciences	813	501	94	18.8% (22.3%)
L0	Social Studies: any area of study	537	362	63	17.4% (2.4%)
H8	Chemical Process and Energy Engineering	1846	1159	180	15.5% (8.7%)
H4	Aerospace Engineering	2435	1386	166	12.0% (13.7%)
Y	Combs of phys/math science with social studies/bus/law	3564	2296	271	11.8% (5.9%)
H3	Mechanical Engineering	6602	3462	400	11.6% (11.1%)
L1	Economics	7187	5450	625	11.5% (6.2%)
H2	Civil Engineering	4942	2529	267	10.6% (8.1%)

Figure 2 – Top 15 JACS2 subject lines, from the complete list of 186, with the highest % of those accepted onto course who studied A levels that studied A Level (A2) Further Mathematics

The second part of this analysis considers STEM and related degree courses using 2010/11 data and compares the AL FM to A levels percentage with 2005/06 data.

An interesting observation from Figure 2 is the wide range of courses meeting the criteria of having at least 10 AL FM students accepted onto the degree and more than 10% of accepted entries with A levels having AL FM. Subjects one would have expected, such as Mathematics, Engineering, Statistics and Physics, are towards the top of the table. Finance and Social Studies are also in the top half, with Economics lower down.

The subject line of G0 Mathematical and Computer Science was top of the table by a considerable margin, with 73.5% of its 83 accepted entries who had A levels having studied AL FM. General Engineering, H1, and Physics, F3, were high up the table, as ranked by the percentage of those with A levels that had AL FM, with 35.4% and 21.1% respectively. Interestingly these had the second and third highest absolute number of AL FM students. Similarly, some subjects such as A1 Pre-clinical Medicine, G4 Computer Science and F1 Chemistry did have a good number of entrants with AL FM (323, 273, 202 respectively), but this represented only a small percentage of their total entrants who had studied A levels (3.2%, 2.7% and 2% respectively) and thus were not included in Figure 2.

In the five years since 2005/06 the vast majority of subject lines in Figure 2 have seen an increase in students with AL FM. The increased access to FM courses and more students studying AL FM, along with competition for university places, will all have contributed.

3. Implications for universities

In the Russell Group Informed Choices Guide (2011), under *What subjects can give me the most options*, the guide lists *facilitating subjects*, i.e. those that are required for university courses more often than others. Both A level Mathematics and Further Mathematics were included. The guide also identified the most common essential and useful A levels for 60 popular university courses. A level Further Mathematics is listed as *useful* for: *Actuarial Science/Studies; Aeronautical Engineering; Biochemistry; Biomedical Sciences (including Medical Science); Chemical Engineering; Chemistry; Computing; Dentistry; Electrical/Electronic Engineering; Engineering (General); Mathematics; Mechanical Engineering; Medicine; Optometry (Ophthalmic Optics); Physics; and Veterinary Science.*

3.1 Suggestions for encouraging the uptake of Further Mathematics

Although some university departments are in a position to make Further Mathematics a requirement for entry to their courses, this is not the case for the majority of institutions. However, universities are able to influence the choice of subjects that students take at A level through their entrance requirements. In turn, this affects the subjects that schools/colleges offer in their sixth form programmes. There are a number of ways that university departments can encourage the study of AS/A level Further Mathematics. Examples of over 50 entry requirement statements that mention Further Mathematics, from Mathematics and other STEM departments, can be seen on the FMSP's Universities' page at www.furthermaths.org.uk/universities.php.

One example is at the University of Plymouth, for their Mathematics degree, where they state: "*AS or A2 Further Mathematics are not essential but will be helpful to our students. We are therefore generally more flexible with applicants who have studied Further Mathematics."* They also go further to say *"We also have a Mathematics and Statistics Entrance Scholarship of £500 for each grade A in Mathematics or Further Mathematics A-level.*"

For Physics at the University of Bath the typical offer is three A levels at grade AAA. However, they state: *"Alternatively, offers may include AS levels. In these cases, Mathematics and Physics at GCE A level (A2 level) are essential, and Further Mathematics is preferred as one of the two subjects at AS level".*

Admission statements which emphasise the importance of Further Mathematics help to create a demand for Further Mathematics, and will in turn lead to more students being better prepared mathematically for STEM degree courses.

4. Concluding remark

University departments who currently do not feel in a position to make Further Mathematics a requirement can still influence prospective students' choices. Including statements that support, highlight or encourage the study of AL FM, or by making more favourable offers to students with a Further Mathematics qualification, help to emphasise its importance. It is through this support from universities that the rise in AL FM numbers will continue. More universities will benefit from the improved mathematical skills and knowledge of students entering onto a wide range of STEM degrees.

5. References

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