

Stimulating an increase in the uptake of Further Mathematics through a multifaceted approach : Evaluation of the Further Mathematics Support Programme.

Stephen Lee and Jeff Searle

Mathematics in Education and Industry and Durham University

Over recent years there has been a marked increase in the number of students studying A-level Further Mathematics in England. In 2012 12,688 students sat the qualification, with the numbers having more than doubled from 5,627 in 2005 (Joint Council for Qualifications figures). The increase has been evident despite the common perception that Further Mathematics is a difficult subject.

The work of Mathematics in Education and Industry's (MEI) government-funded Further Mathematics Support Programme (FMSP) has been highly influential in stimulating this increase through not only enabling all students who wish to study Further Mathematics to have access to tuition, but also through supporting teachers and students in schools and colleges in a variety of ways.

An external evaluation of the FMSP has been undertaken by the Centre for Evaluation and Monitoring at Durham University. This paper reports on aspects of the evaluation and how these relate to the multifaceted approach taken by the FMSP to increase participation in Further Mathematics, including: innovative tuition models, enrichment events, extensive provision for teachers to undertake professional development and also an insight into direct attempts by the FMSP to engage with schools and colleges who have not traditionally offered the subject.

Keywords: Further Mathematics, evaluation, tuition, continued professional development.

Introduction

This paper assumes some familiarity with the UK education system. In brief, most 16 year old students sit formal examinations in subjects including mathematics, known as GCSE or level 2 qualifications. At this stage, academic-pathway students choose to specialise in three or four subjects. Those who wish to continue their study of mathematics to level 3 (advanced level) take A-level Mathematics and in addition they can take A-level Further Mathematics. Both advanced courses in mathematics are available at advanced subsidiary (AS) level, usually a one year course, or the full A-level (A2) which is usually a two year course. Many students choose to take the full A-level in mathematics and the AS-level in Further Mathematics,

Those who study A-level Further Mathematics are exposed to additional and new material beyond that found in A-level Mathematics. Several topics met in A-level Mathematics are developed further such as integration and differentiation, but some completely new topics are studied in A-level Further Mathematics, such as complex

numbers and matrices. The study of applications of mathematics in mechanics, statistics and decision mathematics met in A-level Mathematics can also be extended in Further Mathematics, as well as the topics in pure mathematics.

Background to the FMSP

The services currently offered by the FMSP to students and teachers have evolved over time. Input from external evaluations has played a part in this evolutionary path.

What has now become the FMSP started from a suggestion by a practising teacher prior to the year 2000 who was worried about the decline of Further Mathematics. He suggested that MEI should determine if anything could be done to stem the decline. Subsequently, MEI responded by initiating a pilot project having successfully obtained funding from the Gatsby Charitable Foundation. Details of the pilot project entitled 'Enabling Access to Further Mathematics', including how it was structured, can be seen in Stripp (2002).

The pilot project was deemed to be a success and was highlighted in the report *Making Mathematics Count* by Professor Adrian Smith on post-14 mathematics (2004). Searle (2010, 2008) gave some discussion of the concerns expressed around 2000 by academics in mathematics and other *STEM* subjects as to the lack of readiness of terms of knowledge and fluency in mathematics seen in applicants to degree level courses. Subsequently, in 2004, MEI received funding from the Department for Education and Skills to enable their pilot to be rolled out nationwide in England, with the project becoming known as the Further Mathematics Network (FMN). The basic structure of the FMN was locally based management teams supported and directed by a national central team. The activities of the locally based management teams led to increasing engagement with many schools and colleges and their students and teachers, and the number of students taking Further Mathematics began to grow again. The number of students who took the full A-level in Further Mathematics increased during the lifetime of the FMN from about 5000 to over 9000 (Stripp 2007; Searle 2008).

In 2009 a new contract was awarded for a national Further Mathematics Support Programme (FMSP), which was based on the FMN. MEI won the competitive tender to manage the project centrally (Stripp 2010). As well as the central team of MEI staff, in 2012, the locally based management of the FMSP is through 30 Area Coordinators, who are employed by schools and universities and Local Authorities. The Area Coordinators are now the primary facilitators of day-to-day engagement with schools and colleges and their students and teachers.

FMSP's multi-faceted approach to increasing the uptake of Further Mathematics

The primary goal of the FMSP is to give every student who can benefit from studying Further Mathematics the opportunity to do so. In order to achieve this, a multi-faceted approach has been developed. This approach involves a number of strands of activity, including:

- Innovative tuition models in Further Mathematics
- Enrichment events which aim to inspire students
- A range of opportunities for teachers to undertake professional development

- Direct attempts to engage with schools and colleges who have not traditionally offered the subject

Student tuition

A vital aspect of the national FMSP is its flexibility to meet the particular needs of students and teachers at a local level. For example student tuition by the FMSP is provided in a number of ways, including:

- Face-to-face tuition (very small classes and/or involving school consortia)
- Live Online Tuition (LOT)
- A mixture of the two – Live Interactive Lectures for FM (LIL FM)

To support students preparing for examinations in both A-level Mathematics and Further Mathematics the FMSP offers a revision programme that is also flexible in that it involves online revision events and/or face-to-face events. Student participation in the recent live online events was quite large. Thousands of students, along with a number of teachers, accessed the sessions. The live sessions are recorded and many more thousands of students and teachers viewed the recordings when they were made available after a live session had ended.

Enrichment

The FMSP also offers enrichment events. These events aim to inspire students in mathematics both at Key Stage 4 when they are studying for GCSE and also whilst they are studying at advanced level. There are a number of enrichment opportunities offered by the FMSP:

- Year 10 Team Mathematics Challenge (for students aged 14/15).
There are over 50 regional events, involving over 1000 schools and over 4000 students.
- Senior Team Mathematics Challenge in collaboration with the United Kingdom Mathematics Trust (for students aged 16/17).
There are over 50 regional events, involving over 1000 schools and colleges and over 4000 students. There is also a national final.
- In 2012/13 60 enrichment events for Key Stage 4 students (aged 15/16) are taking place.
These events enable students to meet new ideas in mathematics and its applications, as well as being given challenging problems to solve.
- Other one day events for various age groups including themes such as ‘Maths Works’ and ‘Taking Maths Further’.

Professional development

The FMSP has developed a variety of opportunities for teachers to undertake professional development in the teaching of advanced mathematics. These opportunities include:

- Face-to-face events
- Live Online Professional Development (LOPD) courses
- Extended 15 month professional development courses (Teaching Further Mathematics (TFM) Teaching Advanced Mathematics (TAM))

Many teachers take up these opportunities; during the academic year 2011-12 there were over 1000 teacher days of participation in professional development offered by the FMSP.

Direct engagement

As might be expected with any national project there are a number of schools and colleges who, for whatever reason, don't engage with it. The FMSP has made direct attempts to engage with schools and colleges who have not traditionally offered Further Mathematics, some of which have led to the school or college now offering Further Mathematics. Specific events like the Access to Further Mathematics conferences for senior school leaders and teachers have acted to inform and advise those unsure of the benefits, to them and their students, of having Further Mathematics in their post 16 curriculum offer. These events too have resulted in some schools and colleges now offering Further Mathematics.

Evaluating the FMSP

The Centre for Evaluation and Monitoring (CEM) at Durham University has conducted external and extensive evaluation of the FMSP since its inception in 2009, and of the FMN before then. To date, there have been three reports on the FMN (two interim and one final) and three reports on the FMSP (one interim and two end of Phase reports, see: www.furthermaths.org.uk/fmnetwork_impact.php). A comprehensive review of many of the activities of the FMSP highlighted in the previous section has been included in these evaluation reports. A large numbers of interviews and surveys were conducted; teachers, students, event participants, stakeholders and Area Coordinators were all involved. The evaluators also observed a range of events first hand.

As well as receiving direct feedback on the activities of the FMSP as above, the evaluators at CEM also reviewed student take up and achievement data year-on-year in AS and A-level Mathematics and Further Mathematics. Data on the 2009 and 2012 entries can be seen in Table 1. The percentage change in entries between the two years is also displayed, as is a comparison between 2005 and 2012, which is the lifetime to date of MEI's Further Mathematics project.

Table 1 AS/A-level Mathematics and Further Mathematics certifications in 2009 and 2012 (Source: Joint Council for Qualifications)

	2009	2012	2009-2012 percentage change		2005-2012 percentage change
A-level Further Mathematics	10073	12688	26%		125%
AS-level Further Mathematics	12710	20370	60%		324%
A-level Mathematics	66552	78951	19%		64%
AS-level	95408	139585	46%		46%

Mathematics					
-------------	--	--	--	--	--

The complete evaluation can be seen on the FMSP website (www.furthermaths.org.uk/fmnetwork_impact.php). Included within the evaluation reports was a summary that stated:

The FMSP is an effective and successful organisation, evidenced by the growth in student numbers and the positive feedback from teachers when interviewed from the perspective of a range of activities. Searle (2012, 31)

It went on to say:

The work of the FMSP is highly valued by students, teachers and more generally by stakeholders, and this work should continue. Searle (2012, 31)

In summary

A brief overview of the strategies employed by the FMSP to enable any student who could benefit from studying Further Mathematics to do so has been provided.

Support for students and teachers has been at the heart of the success of the FMSP. Student support includes tutoring, enriching, and inspiring students in mathematics. Teacher support includes professional development, advice, guidance and information in developing Further Mathematics in their school or college. It is predominantly the actions and enthusiasm of the Area Coordinators to meet needs and demands in their local area that has now enabled many more students to study Further Mathematics and teachers to teach Further Mathematics in a way that engages and motivates students.

References

- Searle, J. 2008. Evaluation of the Further Mathematics Network. In *Improving Educational Outcomes Conference*, Durham University.
- Searle, J. 2010. Investigating the impact of the Further Mathematics Network. *Proceedings of the British Society for Research into Learning Mathematics*, 30 (1): 207-214.
- Searle, J. 2012. Evaluation of the Further Mathematics Support Programme 2009-2012 - Summary Report: August 2012
www.furthermaths.org.uk/fmnetwork_impact.php
- Smith, A. 2004. Making Mathematics Count: The report of Professor Adrian Smith's Inquiry into post-14 mathematics education. London: DfES.
- Stripp, C. 2002. Enabling access to Further Mathematics. *MSOR Connections*, 2 (4): 19-22.
- Stripp, C. 2007. The Further Mathematics Network. *MSOR Connections*, 7 (2): 31-35.
- Stripp, C. 2010. The end of the Further Mathematics Network and the start of the new Further Mathematics Support Programme. *MSOR Connections*, 10 (2): 35-40.