



EEG

Education Evaluation Group

Evaluation of the Further Mathematics Support Programme

Report on Phase 2

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Executive Summary

Phase 1 of this evaluation covered the period from the formation of the Further Mathematics Support Programme in August 2009 to February 2010. Phase 2 covers the period up to March 2011.

The FMSP is making considerable progress towards achieving its aims of widening access to Further Mathematics, increasing the number of students who study both AS level and A level Mathematics and Further Mathematics and developing the knowledge, expertise and confidence of teachers to teach Further Mathematics in their own schools and colleges.

An analysis of entry and achievement data from both the Department for Education and the Joint Council for Qualifications shows that student numbers in both Mathematics and Further Mathematics continue to grow year on year. The number of schools and colleges offering Further Mathematics also continues to grow.

The questionnaire based survey of Phase 1 of 500 schools and colleges was repeated with a different sample of 500 schools and colleges with about a 25% response rate. The survey indicated wide awareness of the FMSP and the services it offers as regards Further Mathematics but there was little awareness, or interest, in the level 3 Diploma in Engineering. The actual use of the FMSP's services, or those that were considering using some of the services, varied widely with different schools and colleges.

Subsequent telephone interviews with willing respondents from the survey, indicated considerable support for the FMSP. Many teachers noted that Further Mathematics would not have been initiated and would not have developed in their establishment without the support of the FMSP. They valued the role of the FMSP in raising the profile and development of mathematics education in England.

The interviews also found that teachers identify a range of need in terms of professional development, from no need to those in establishments where staff regularly take up opportunities for professional development. However, most teachers recognise the value of refresher courses for experienced teachers and also the need to develop the knowledge, expertise and confidence of new teachers, so that they can teach Further Mathematics. Teachers generally indicated a preference for face-to-face professional development events, rather than online provision, although the latter was much appreciated by those who had used it. The face-to-face events and the online provision are discussed in detail in this report. The FMSP has also initiated Knowledge Networks across England, and these and the collaboration between the FMSP and the United Kingdom Mathematics Trust (UKMT) to run the Senior Maths Challenge, give teachers further opportunity for professional development. Actual "hands-on" experience by the evaluator of all the types of professional development and the evaluative feedback collected by the FMSP, support the value that teachers find in these events and opportunities. Teachers value their reinforced knowledge and understanding, their increased confidence to teach Further Mathematics and the sharing of ideas and resources to use in their classrooms.

A survey was also conducted on the level 3 Diploma in Engineering with a sample of 30 establishments. It was difficult to identify establishments that offered the Diploma and the response was very poor, but showed little awareness of the FMSP. The resulting telephone interviews showed a general concern about the mathematics in the compulsory unit of the Diploma, finding it too demanding and lacking in relevance to the intended students.

A major aspect of this evaluation was to investigate the provision of Further Mathematics in schools and colleges that are working in a consortium arrangement and / or are working towards taking the teaching 'back in house', rather than using the tuition services of the FMSP. It became apparent from information supplied by the FMSP Area Coordinators, and subsequent telephone interviews with a sample of teachers, that establishments are experiencing various levels of success with this. Whilst many mathematics departments are trying to establish Further Mathematics as an option in the post 16 timetable, some have not been able to do so, and some have only had partial success. A common arrangement was for an establishment to teach the AS level themselves and then use the FMSP for the A2 modules to complete the A level. In all establishments the demand for Further Mathematics was very much student driven; students realise the value of studying Further Mathematics to their future career plans. The establishments also had committed teachers who wanted to support their students and also wanted to teach some Further Mathematics themselves.

The provision of Further Mathematics in establishments in consortia or working to take the teaching 'back in house', is fragile and there are budgetary barriers to sustainability and growth. There is a dilemma in that senior management, although supportive in many places, want to see viable numbers before they will agree to put Further Mathematics on the timetable, whilst Year 11 students want reassurance that Further Mathematics will be offered in their school, or they will go elsewhere for post 16 study. However, there was general optimism that growing awareness of Further Mathematics among Year 11 students would ensure its continuing development.

A survey of students who had experienced tuition through the FMSP indicated that they were generally positive and grateful for the opportunity to study Further Mathematics. There was some criticism, but mostly about administrative matters, with many finding both mode of study and the mathematics studied to have helped them when starting higher education courses. This was reinforced by some subsequent telephone interviews with students.

A range of prominent stakeholders in Mathematics education in England were invited to give a view on the FMSP. Many responded and they are all very positive about the FMSP and what it has achieved in promoting Further Mathematics.

This report concludes that the DfE should continue to fund the FMSP. The FMSP is succeeding in its key aims and teachers value what it does and want it to continue. Students value the opportunities it offers that might not otherwise be available to them. Some recommendations for further development are made.

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1. Introduction and review of Phase 1

1.1 Response to Phase 1 report by FMSP

The recommendations from the Phase 1 report, together with the FMSP's responses, are given below.

- Continue to promote Further Mathematics to all pre-16 students who could benefit, but particularly female students, so that the gender imbalance continues to be addressed.

With funding from the Clothworkers' Foundation, the FMSP ran 40 very successful Key Stage 4 enrichment events in the summer term of 2009/10 and the autumn term of 2010/11.

Under the new FMSP contract the FMSP aims to expand its work to promote Further Mathematics to pre-16 students, and to continue to work to address the gender balance in the take up of Further Mathematics.

- Maintain contact with all schools and colleges in each FMSP region, keeping them up-to-date with what the FMSP has to offer and how to get involved.

This continues to be a strong priority of the FMSP Area Coordinators.

- At a local level, continue to facilitate focus groups, or local forums, enabling teachers to meet, not necessarily under a "CPD umbrella", to encourage exchange of ideas, teaching strategies and the issues involved; this could include demonstrations by FMSP of the *Illuminate* software and its use in online CPD provision and revision for students.

*The FMSP, working in partnership with the NCETM, has expanded its work in this area, and has worked hard to promote the use of live online sessions using *Illuminate*, resulting in increased uptake of online CPD and increased attendance at online revision events.*

- Work in conjunction with MEI to keep developing the web-based resources for Mathematics and Further Mathematics, including enrichment ideas and links that might be used across the year groups in an 11-18 school.

The MEI online resources continue to expand and under the new FMSP contract it is planned to further enhance materials to stimulate interest in AS level and A level Mathematics and Further Mathematics amongst pre-16 students.

- Work in conjunction with MEI to develop further resources, particularly for both A2 Mathematics and Further Mathematics modules. This might include both online resources and resources using other aspects of ICT, such as ready made provision for inter-active whiteboards, or

PowerPoint presentations on topics, and also paper-based interactive materials, that teachers can adapt to their students' needs.

The FMSP works closely with MEI to guide the development of MEI's online resources and the types of resources detailed in the recommendation are being prioritised.

1.2 Introduction to report on Phase 2

Phase 1 of the evaluation included the following aspects:

- (i) A measure of awareness in schools and colleges of:
 - courses and qualifications available in further mathematics
 - level 3 mathematics units available for level 3 diplomas
 - support and activities offered by the FMSP to students and teachers
 - CPD opportunities for teachers
- (ii) Establishment of a baseline from which to measure progress of the FMSP towards its aims.
- (iii) A review of the self-evaluation performed by MEI since the commencement of the FMSP.

A final report on Phase 1 of the evaluation was submitted to the DCSF in May 2010.

In Phase 1 of the evaluation it was concluded that the Further Mathematics Support Programme (FMSP) was continuing the positive development of AS level and A level Further Mathematics made during the era of the former Further Mathematics Network (FMN). It was found through the telephone interviews that those establishments where Further Mathematics had been flourishing for many years were pleased that the FMN had continued as the FMSP; teachers recognised the achievements made and the need to maintain the momentum in increasing the number of students participating in Further Mathematics and also enhancing mathematics education in general. It was also found that many establishments were continuing to make use of the various services of the FMSP, and value the various activities that involvement in the FMSP has to offer whilst others were considering making use of some of these services. However, it was also concluded that there was room for further development.

In the Phase 1 report a baseline was established for student entries and achievement in GCE AS level and A level Further Mathematics. The academic year 2008/09 was chosen as the appropriate baseline year as it was the last year in which the former Further Mathematics Network had direct influence on entries and results. An analysis of the 2009/10 results, as published by the Department for Education, is included in the Section 2 of this report; 2009/10 is the first year in which the FMSP has had opportunity to influence entries and results following its establishment in August 2009. Section 2 of this report firstly looks at the growth in numbers taking Further Mathematics in England using figures published by the Joint Council for

Qualifications (JCQ), where they are compared with those for Wales and Northern Ireland. Also included is a comparison of the overall pass rates of students who received tuition through the FMSP compared to the all England pass rates, again using JCQ figures.

In Phase 2 of the evaluation a second survey of schools and colleges was carried out on a second sample. Teachers who responded to the survey were again invited to take part in a telephone interview to expand on their views of the FMSP and its services. The survey and telephone interviews were also extended to include establishments that offered the level 3 Diploma in Engineering. The results of these surveys and findings from the telephone interviews are discussed in Sections 3 and 4 of this report.

A major aim of the FMSP is to enable schools and colleges to take the teaching of Further Mathematics 'back in house', so that teachers from the establishments are teaching at least some of the Further Mathematics modules themselves, rather than relying on teaching provided by FMSP tutors. Another aspect of this is the formation of consortia of schools and / or colleges, where the teaching, or at least some of it, is offered to students from the group of establishments that form the consortium, by teachers from those establishments. The Area Coordinators (ACs) of the FMSP identified such establishments in their region, and telephone interviews were conducted with teachers from some of these. The findings from these interviews are reported on in Section 5 of this report.

A major aspect of Phase 2 of the evaluation was to investigate in depth the continuing professional development (CPD) opportunities offered by the FMSP and teachers' reactions to them. There are several types of such opportunity, including face-to-face day events with tutors, the fourteen month long Teaching Further Mathematics course (TFM), remote online courses, Knowledge Network sessions and also the Senior Team Mathematics Challenge competition for students. These are reported on in Section 6 of this report.

Another aspect of Phase 2 was to collect the views of various stakeholders who have an explicit interest in the activities of the FMSP. Foremost in these stakeholders are the students themselves, and the results of a survey of students who studied Further Mathematics using tuition received through the FMSP are given and discussed in Section 7. The views of some prominent stakeholders in mathematics and STEM education have also been sought and these are reported in Section 8.

Section 9 draws together the conclusions from the evaluation and makes recommendations for further development.

2. Further Mathematics 2004 – 2010

2.1 Growth in entries

The figures used in Table 1 to show the growth in the number of candidates entering for a qualification in Further Mathematics are those of the Joint Council for Qualifications, which are published each August after the examinations have taken place in May/June. These differ from the figures released later by the Department for Education, as explained below, but are suitable for comparative purposes, both for year on year growth, and for comparison with Wales and Northern Ireland, whose figures are also published by the Joint Council for Qualifications.

The Department for Education (DfE) figures for GCE A and AS level examinations by subject and grade differ from those published by Awarding Bodies in August. The Awarding Bodies' figures relate to the outcome of the individual subject areas for all candidates in England, Wales and Northern Ireland, regardless of their age. The figures published in the Statistical First Release by the DfE focus on the overall performance of candidates aged 16, 17 or 18 taking these examinations in England only.

Although the numbers of candidates entering Further Mathematics are much higher in England compared to Wales and Northern Ireland, the percentage change in England over the 7-year period 2004 to 2010 is much higher than in the other two countries. In England it is seen that growth in entries in both A level and AS level was sustained from 2009 into 2010 but this was only mirrored by the AS level in Wales, otherwise numbers in the other two countries have decreased. Given that the FMSP operates only in England, there is evidence here of the FMSP having a significant impact and being influential in the growth in entries.

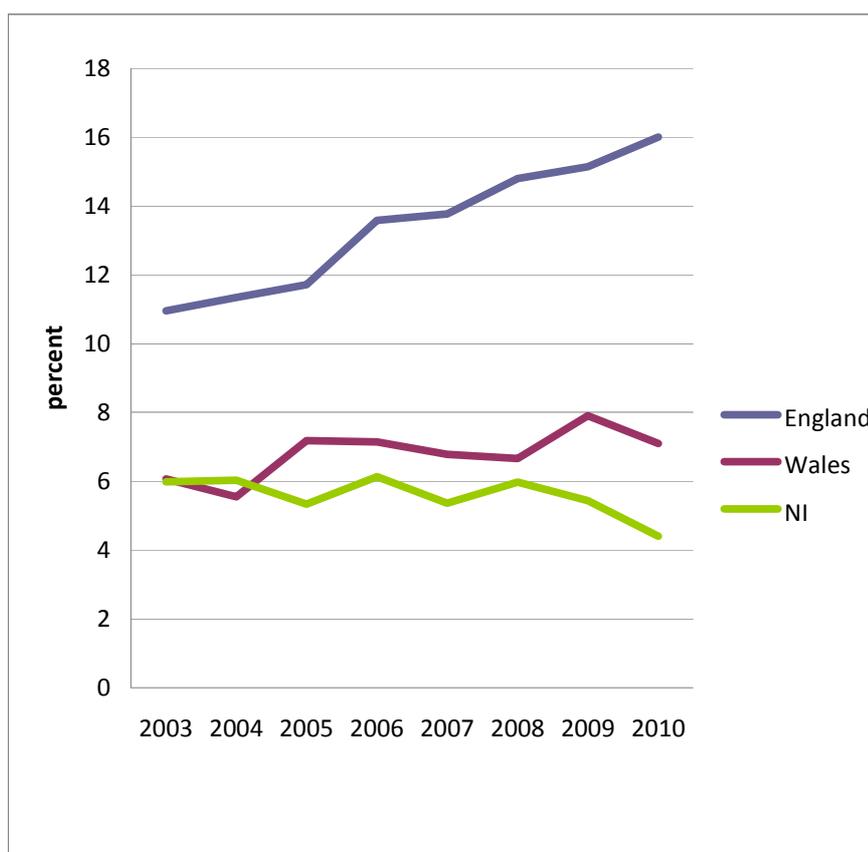
Table 1
Number of candidates entering A level and AS level Further Mathematics

		2004	2007	2004-2007 percent change	2009	2010	2004-2010 percent change	2009-2010 percent change
England								
	A level	5443	7551	39%	10073	11312	108%	12%
	AS	3761	7124	89%	12710	14414	283%	13%
Wales								
	A level	138	186	35%	250	240	-4.0%	-4%
	AS	94	145	54%	245	275	12.2%	12%
Northern Ireland								
	A level	139	135	-3%	150	130	-13.3%	-13%
	AS	125	157	26%	209	195	-6.7%	-7%

source JCQ

Another comparison can be made using the proportion of candidates who have taken A level Mathematics and Further Mathematics in the three countries. This is shown graphically in Figure 1.

Figure 1 A level Further Mathematics entries as a percentage of A level Mathematics entries



source JCQ

It is seen in Figure 1 that the number of candidates taking both A level Mathematics and A level Further Mathematics has been growing steadily in England, but this is not the case in Wales and Northern Ireland. The percentage in Wales has been fairly consistent, whereas in Northern Ireland it has a downward trend. This is further evidence of the positive impact of the activities of the FMSP on the take up of Further Mathematics in England.

DfE data show that between 2005 and 2009 the proportion of state funded schools in England with students taking A level Mathematics that also had students taking A level Further Mathematics rose from 40% to 60%. This indicates that while there has been a considerable increase in access to Further Mathematics in the state sector in England, there is still much to be done. DfE data also show that in 2009 13% of A level Mathematics students educated in the state sector also took A level Further Mathematics. In the independent sector the figure was 21%. This also indicates that there is still work to be done to improve access to Further Mathematics in the state sector.

2.2 Achievement against the Baseline

GCE A level Further Mathematics

Table 2 below shows the baseline entry figures and the percentage of students who achieved each grade for the baseline year 2008/09, the year before and the year after, the first year of operation of the FMSP. This is also shown broken down into male and female students.

Table 2 GCE A level Further Mathematics entries

All student entries – percentage achieving grade									
Academic year	A*	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	29.3	30.1	20.2	11.4	5.4	2.8	99.3%	10813	14.5%
2008/09		59.1	20.2	11.0	5.4	3.2	99.0%	9443	11.8%
2007/08		58.2	20.6	11.1	5.7	2.9	98.4%	8447	16.7%
Male student entries – percentage achieving grade									
2007/08	30.0	29.3	20.3	11.1	5.5	3.1	99.2%	7369	13.5%
2008/09		59.4	19.7	10.4	5.8	3.6	98.9%	6493	10.6%
2007/08		58.0	20.1	11.3	5.7	3.1	98.3%	5871	15.1%
Female student entries – percentage achieving grade									
2007/08	27.7	31.9	20.1	12.0	5.3	2.3	99.3%	3444	16.7%
2008/09		58.6	21.3	12.4	4.6	2.3	99.2%	2950	14.5%
2007/08		58.7	21.7	10.4	5.5	2.4	98.7%	2576	20.3%

source DCSF/DfE

The growth in the number of entries in A level Further Mathematics between 2003/04 when the Further Mathematics Network (FMN) first formed, up to 2009/10, and the percentage of students achieving each grade, are shown in Tables A1, A2 and A3 (Appendix 4).

In Table 2 it is seen that the large increase year on year in student entries during the period 2003/04 to 2008/09 was sustained into 2009/10. The number of entries increased by 5702 students or a 111.6% increase in 2009/10 compared to 2003/04.

It is also seen that although in terms of percentages the growth in numbers is greater for female students than male students from 2008/09 into 2009/10, the actual number of male students is more than double that of the female students. The proportion of male students has dropped a little over the last three years from 69.5% in 2008 to 68.1% but there is still a role for the FMSP to continue to encourage a greater number of female students to take up A level Further Mathematics, as well as sustaining the growth in numbers for all students.

GCE AS level Further Mathematics

Table 3 below shows the equivalent figures to Table 2 for AS level Further Mathematics. It should be noted that there is some ambiguity in the figures for AS level Further Mathematics because of the variety of ways in which schools and colleges can choose to enter students for certification. Some students who complete a full A level in Further Mathematics do not certificate AS level Further Mathematics at all, whilst other students certificate AS level Further Mathematics at the end of year 12, before certificating A level Further Mathematics in year 13. Furthermore, some students choose to take AS level Further Mathematics only, with some taking it in year 12, some studying it over years 12 and 13 and some taking it up in year 13. It would be useful to know how many students take AS level Further Mathematics only, without progressing to the full A level, but these data are not currently available.

Table 3 GCE AS level Further Mathematics entries

All student entries – percentage achieving grade								
Academic year	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	41.9	19.2	13.8	10.6	6.9	92.5%	9421	12.2%
2008/09	41.0	19.7	15.0	10.3	7.0	93.1%	8399	48.5%
2007/08	37.6	20.2	15.9	10.9	7.4	92.0%	5654	15.1%
Male student entries – percentage achieving grade								
2009/10	40.3	18.9	13.9	10.9	7.4	91.4%	5911	13.9%
2008/09	39.3	19.1	15.5	10.6	7.8	92.4%	5190	45.5%
2007/08	35.8	20.0	16.2	11.4	7.8	91.1%	3567	15.8%
Female student entries – percentage achieving grade								
2009/10	44.6	19.7	13.7	10.1	6.2	94.3%	3510	9.4%
2008/09	43.8	20.7	14.1	9.9	5.7	94.2%	3209	53.8%
2007/08	40.7	20.5	15.5	10.1	6.8	93.6%	2087	13.9%

source DCSF/DfE

The FMSP would like to increase the number of students choosing to study AS Further Mathematics in Year 13, in preparation for taking degree courses in Science, Technology, Engineering and Mathematics (STEM) in Higher Education, but it is difficult to establish an accurate baseline for this. Establishing such a baseline is something the FMSP could look into, in collaboration with the DfE.

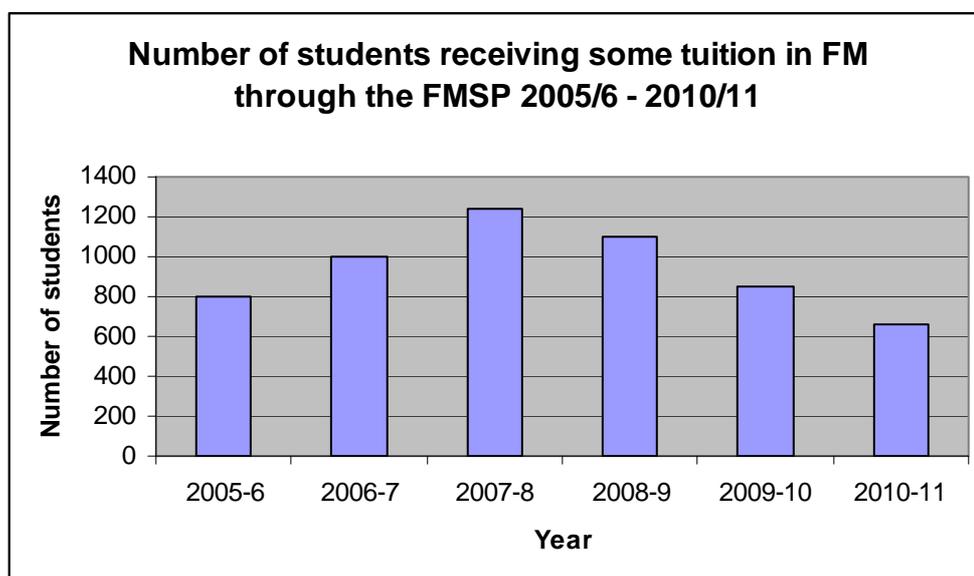
The full set of entry figures for 2003/04 to 2009/10 for the entries in GCE AS level Further Mathematics are shown in Tables A4, A5 and A6 (Appendix 4).

In Table 3 it is seen that the large increase year on year in student entries during the period 2003/04 to 2008/09 was sustained into 2009/10. The number of entries increased by 6866 students or a 267.7% increase in 2009/10 compared to 2003/04. The year on year increase was not as large as that seen between 2007/08 and 2008/09 where there was an almost 50% increase. The scale of this increase was almost certainly influenced by a change to the Edexcel Further Mathematics specification, to bring it into line with the other Awarding Bodies' specifications. This change made it possible to complete Edexcel's AS Further Mathematics during Year 12. Changes to the certification rules relating to GCE Mathematics and Further Mathematics at this time will also have had an effect. Data are not available to enable these effects to be quantified, but it is notable that the total entries for AS level Further Mathematics continue to grow.

It is also seen in Table 3 that although there have been substantial increases in numbers for both male and female students, the number of male students is higher. However, the proportion of male students is a little smaller than that for A level Further Mathematics at 62.7% in 2010, which itself is just a little smaller than the 2008 figure of 63.1%, again emphasising the need for the FMSP to continue its work in trying to attract more female students to take Further Mathematics.

2.3 FMSP student numbers

The chart below shows the number of students receiving some tuition in Further Mathematics through the FMSP from 2005/6 – 2010/11 (These data were provided from the FMSP Database).



source FSMP

It is evident that after an initial increase in numbers, since 2007/08 there has been a decline. The graph shows that the number of FMSP students has dropped over the last three years, whilst overall numbers have risen. This is evidence that more schools and colleges are able to teach their own students.

2.4 Comparison of achievement of FMSP students to all students

Table 4 below shows the pass rates achieved by students who received tuition from the FMSP compared to those achieved by all students in England, using JCQ figures for the last three years.

It is seen in Table 4 that the achievement by students who received their tuition through the FMSP in terms of pass rate, is in general compatible with that of all students. Previous analysis of the performance of FMN students has shown that there is no statistically significant difference in their performance in Further Mathematics A level. As such, there would appear to be no disadvantage to students who study Further Mathematics through the FMSP.

Table 4
Pass rates in AS and A level Further Mathematics 2007/08 to 2009/10

		A level Further Mathematics		AS level Further Mathematics	
		FMSP	All England	FMSP	All England
2009/10	Pass rate	98.8%	98.4%	97.0%	95.4%
2008/09	Pass rate	100%	98.2%	91.6%	95.7%
2007/08	Pass rate	98.8%	97.7%	90.6%	95.7%

source FMSP/JCQ

2.5 Establishments offering Further Mathematics

Table 5 below shows the baseline for 2008/09 compared to the 2007/08 in terms of types of establishment offering AS level Further Mathematics and/or A level Further Mathematics and updates this to 2009/10.

In Table 5 it is seen that although there is some small variation amongst different types of establishment, some of which may be due to some schools changing their status, the overall trend is an increase in the number of establishments that are offering their students the opportunity to study for qualifications in Further Mathematics.

Table 5 Establishments offering Further Mathematics

Type of Establishment	Offering A level Further Mathematics			Offering AS level Further Mathematics		
	2007/08	2008/09	2009/10	2007/08	2008/09	2009/10
Academies	10	17	26	14	19	28
City Technology College	3	1	2	1	3	3
Community School	445	415	441	422	437	458
Foundation School	210	294	300	206	282	292
Further Education	170	163	164	171	174	175
Independent schools	404	418	414	281	286	310
Non maintained special school	0	0	2	0	1	1
Voluntary aided schools	179	209	210	178	208	208
Voluntary controlled schools	55	50	51	44	44	45
Other government funded	5	1	4	2	1	2
Totals all establishments	1481	1568	1614	1319	1455	1522
Totals all state establishments	1077	1150	1200	1038	1168	1212

source DfE

The evaluation also considered how the Further Mathematics Status of an establishment changed from 2009/10 to 2010/11. The table below shows the Further Mathematics (FM) status definitions used by the FMSP.

FM status	FM offered?	FM Tuition
1	Y	When there is demand for FM, all FM teaching is performed 'in house' (either by the school/college itself, or through a consortium). There is no reliance on support from the FMSP.
2	Y	When there is demand for FM, all FM teaching is performed 'in house' (either by the school/college itself, or through a consortium). The school/college or consortium receives CPD from the FMSP to support its FM teaching.
3	Y	When there is demand for FM, the school/college/consortium only teaches some FM modules that are essential to the delivery of AS and/or A level FM; others are taught externally. This category does not include cases where external tuition is used to provide alternative, but non-essential module options (e.g. high level Mechanics).
4	Y	When there is demand for FM, all teaching is provided by the FMSP.
5	N	The school/college does not offer FM to its students, or there is no evidence to suggest that the subject is offered.

The table below shows how the FM statuses changed, as recorded on the FMSP database. For example, the figure 77 indicates that 77 establishments changed their status from 5 in 2009/10 to 1/2 in 2010/11.

		2009-10 FM Status			
		1/2	3	4	5
2010-11 FM Status	1/2	810	46	24	77
	3	13	12	8	4
	4	2	2	27	7
	5	9	2	3	36

FM provision improved (166 establishments)
FM provision stayed the same (885 establishments)
FM provision reduced (31 establishments)

source FMSP

It is clear that the Further Mathematics provision stayed the same for the majority of establishments, but a greater number improved (166) than reduced (31). In particular Further Mathematics provision improved in 147 establishments to status 1/2, meaning they offered Further Mathematics in house in 2010/11, but had not offered it in 2009/10. Only 14 establishments reduced to status 5, indicating that they had offered Further Mathematics in 2009/10, but did not offer it in 2010/11.

2.6 A level and AS level Mathematics

The influence of the FMN and subsequently the FMSP has extended beyond just Further Mathematics to mathematics education in general and in particular to GCE A level Mathematics and AS level Mathematics. It is thus considered that the mainstream mathematics courses at level 3 should form part of the baseline as the FMSP has the support of level 3 mathematics as part of its brief.

Tables 6 and 7 below show the total entry figures and the percentage of students who achieved each grade for the baseline year of 2008/09, the previous year and for 2009/10.

Table 6 GCE A level Mathematics entries

All student entries – percentage achieving grade									
Academic year	A*	A	B	C	D	E	Pass rate	total entry	percentage increase
2009/10	17.0	27.9	22.0	15.5	10.1	6.0	98.5%	69803	8.2%
2008/09		45.4	21.7	15.3	10.1	5.8	98.3%	64517	12.0%
2007/08		44.2	22.2	15.4	10.2	6.0	98.0%	57618	8.0%
Male student entries – percentage achieving grade									
2009/10	17.3	27.4	21.3	15.4	10.5	6.5	98.4%	41552	8.2%
2008/09		44.4	21.2	15.6	10.7	6.2	98.1%	38408	10.3%
2007/08		43.0	21.7	15.7	10.7	6.6	97.8%	34809	8.3%
Female student entries – percentage achieving grade									
2009/10	16.6	28.8	23.0	15.7	9.5	5.2	98.7%	28251	8.2%
2008/09		46.7	22.5	15.0	9.2	5.1	98.6%	26109	14.5%
2007/08		45.9	23.0	14.9	9.5	5.0	98.3%	22809	7.7%

source DCSF/DfE

The full set of entry figures for 2003/04 to 2009/10 for the entries in both GCE AS and A level Mathematics are shown in Tables A7 and A8 (Appendix 4).

Table 7 GCE AS level Mathematics entries

All student entries – percentage achieving grade								
Academic year	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	23.5	16.5	15.5	14.2	12.3	81.9	79458	7.8%
2008/09	23.3	15.3	15.1	14.9	12.9	81.5	73728	11.4%
2007/08	23.6	15.7	15.4	14.4	12.5	81.6	66208	5.3%
Male student entries – percentage achieving grade								
2009/10	22.8	15.2	14.9	14.4	12.7	80.0	46279	8.8%
2008/09	22.2	14.3	14.5	14.9	13.5	79.5	42555	11.0%
2007/08	22.2	14.9	14.9	14.4	13.1	79.6	38325	4.0%
Female student entries – percentage achieving grade								
2009/10	24.6	18.2	16.2	14.0	11.7	84.6	33179	6.4%
2008/09	24.9	16.6	16.0	14.8	11.9	84.2	31173	11.8%
2007/08	25.5	16.9	16.0	14.3	11.7	84.4	27883	7.0%

source DCSF/DfE

In Tables 6 and 7 it is seen that the large increases year on year in student entries during the period 2003/04 to 2007/08 were sustained into 2009/10. Between 2003/4 and 2009/10 the number of entries increased by 23786 students at A level and 28421 students at AS level, increases of 51.7% and 55.7% respectively.

The government target of 56000 A level Mathematics students by 2014 was passed in 2007/08. In 2009 this target was revised to 80000.

Part of the challenge to the FMSP, through its various support activities, is to support continued growth in AS and A level numbers in both Mathematics and Further Mathematics. All the above figures are evidence that substantial growth has occurred and it seems probable that the FMSP has had a substantial influence in bringing about the growth.

3. Second survey: results and analysis

3.1 Further Mathematics and level 3 Diploma in Engineering

In Phase 1 of the evaluation 2011 schools and colleges in England were identified as state funded establishments that had at least one student entered for AS level or A level Mathematics in the year 2007-08. A sample of 501 schools and colleges was drawn from these establishments, stratified by the number of them which were located in each of the nine regions of England. This sample was surveyed in December 2009 and January 2010, with 114 responses. A second sample of 501 establishments was similarly surveyed in October and November 2010, with 130 responses. The survey questionnaires were nearly identical for both surveys, the only changes being

in questions 1 and 6. The revised questionnaire is in Appendix 1. In question 1, respondents were asked simply whether they were aware of the FMSP rather than had they read its introductory leaflet, and in question 6 the term 'network' was replaced by 'consortium' to clarify what the question was asking.

Responses from the first survey are reproduced in Tables 8(i) and 8(ii) for comparison with the second survey, which are shown in Tables 9(i) and 9(ii). It should be noted that as regards Q5, the "No response" indicates that an establishment is currently using or is considering using at least one of the FMSP services (Q5a to Q5h) whereas the "No" indicates that an establishment is not currently using nor is considering using FMSP services.

Table 8(i) Results of first survey

	Q1	Q2a	Q2b	Q3	Q4	Q5	Q6
No response	4	2	7	2	10	107	4
Yes	77	105	95	13	90		41
No	33	7	12	99	14	7	69
	114	114	114	114	114	114	114

Table 9(i) Results of second survey

	Q1	Q2a	Q2b	Q3	Q4	Q5	Q6
No response		1	4	4	5	124	
Yes	122	120	114	12	108		30
No	8	9	12	114	17	6	100
	130	130	130	130	130	130	130

Table 8(ii) Results of first survey

	Q5a	Q5b	Q5c	Q5d	Q5e	Q5f	Q5g	Q5h
No response	61	44	99	32	96	32	27	27
Use	18	27		22		43	39	29
Would consider	35	43	15	60	18	39	48	58
	114	114	114	114	114	114	114	114

Table 9(ii) Results of second survey

	Q5a	Q5b	Q5c	Q5d	Q5e	Q5f	Q5g	Q5h
No response	84	64	110	46	108	32	31	30
Use	16	23	1	25	2	51	54	36
Would consider	30	43	19	59	20	47	45	64
	130	130	130	130	130	130	130	130

In comparing Tables 8(i) and 9(i) it is seen that the results are very similar, although awareness of the FMSP in the more recent survey, Q1, is seen to be 94%, compared to 70% who had seen the leaflet in the first survey. The number of respondents, Q2, saying they offer both AS level and A level Further Mathematics was about 90% on both surveys (note that DfE data show that 60% of state funded schools and colleges in England actually had students taking A level Further Mathematics in 2009), whereas again in Q3 it is seen that very few establishments offer the level 3 Diploma in Engineering.

It is seen in both surveys that not all establishments who offer Further Mathematics are registered with the FMSP but the large majority are, this being 88% in the second survey compared to 79% in the first survey. The responses to Q5 are very similar, indicating that most respondents are at least considering using one or more of the services that the FMSP offers. There is little basis for comparing Q6 due to the changed wording, but it is seen in the second survey that 30 of the respondents consider their establishment to be working with at least one other school or college to deliver KS5 mathematics.

Questions 5a through to 5h refer to services offered by the FMSP and respondents had the option of no response, or indicating they currently use the service, or that they would consider using the service.

The number of establishments using tuition, Q5a, offered by the FMSP was a little higher in the first survey at 16%, compared to about 12% in the second survey. In the second survey again somewhat fewer respondents indicated they were considering using the tuition service, but combining the two surveys indicates about 27% of establishments are considering this. Q5b indicates relatively fewer respondents using or considering advice from the FMSP, but it is still about 50% of the respondents. Both surveys indicate, Q5c, that there is little interest at present in the level 3 Diploma in Engineering, although about 14% of all the respondents said they are considering seeking advice about the mathematics involved through the FMSP. For professional development, the second survey indicated a similar number to the first currently using CPD offered by the FMSP at just under 20%, with a slightly fewer thinking about it, although in combining the samples about 70% of the respondents would at least consider taking up this service. The numbers interested in CPD for the Diploma, Q5e, were similar to those who might seek advice about teaching the mathematics involved. The number of respondents who indicated they use, or would consider using the revision events provided by the FMSP were similar in both surveys; for the second survey the figures for mathematics were 41% and 36% and for Further Mathematics 42% and 35% respectively. The number of respondents indicating that their establishment uses or would consider using enrichment events provided by the FMSP for any year group were similar in both surveys, with about 28% using this service with about another 50% considering using it.

3.2 Mathematics for the level 3 Diploma in Engineering.

It proved difficult to identify establishments that were actually offering the Engineering Diploma at level 3 in 2010/11. Ultimately, using the *Directgov* 14-19 prospectus website (<http://yp.direct.gov.uk/14-19prospectus/>), 60 such establishments were identified that appeared to be offering this course, some of them in a consortium arrangement. This comprised 33 colleges, 21 schools and 6 consortium arrangements, not clearly identified with a particular school or college. A questionnaire, similar to that used for Further Mathematics, but customised for the Diploma, was sent to the given contact address of 17 of these colleges and 12 of the schools (see Appendix 2). Of these, only seven were returned, four from colleges and three from schools; two of the schools and two of the colleges agreed to an interview.

Results of the questionnaire

The three schools that returned questionnaires were aware of the existence of the FMSP and registered with it, but none of the colleges knew about it, although it was acknowledged by one that the FMSP might be known to the mathematics department. One of the colleges was no longer running the course and another indicated they would not be running it next year. None of these schools or colleges was currently making any use of the FMSP services and only one college indicated any interest in doing so. The three schools were involved in delivering the course through a local consortium but none of the colleges.

Little can be concluded from the questionnaire because the returned sample is so small, but it does seem that if the FMSP is to continue to support the mathematics of the diploma, information about the services available needs to reach the staff who are actually delivering the course. In big FE colleges this tends to be engineering departments where the course is seen as vocational.

4. Analysis of telephone interviews

4.1 Further Mathematics and level 3 Diploma in Engineering

Against a target of 50 telephone interviews from the survey (Section 3) 42 interviews were conducted. The interviews covered a range of schools and colleges geographically spread across England. In conducting these interviews the evaluator followed a pro-forma so that all interviewees were asked the same questions during the discussion. The discussion was also informed by the interviewee's response to the questionnaire. Interviewees were asked to answer as regards the situation in their school or college, rather than give any personal opinions. The teachers interviewed were predominantly from 11-18 schools but also included six post-16 colleges. The schools were mostly mixed schools but included some single sex schools. Also, most of the schools were comprehensive schools but included some grammar schools and academies.

The interviews were typically between 15 and 20 minutes in duration and covered the following areas.

- (a) Current numbers of students taking Further Mathematics at AS level and at A2 level.
- (b) Current number of students taking Mathematics at AS level and at A2 level.
- (c) Has there been recent growth? If so, can you account for it?
- (d) What are the timetabling arrangements for Further Mathematics?
- (e) What engagement has there been with the FMSP?
- (f) What are the perceived professional development needs of A level teachers?
- (g) Revision events and online revision opportunities for students.
- (h) Enrichment opportunities for all students.
- (i) What use is made of the FMSP / MEI resources?
- (j) Is there anything else you would like to see the FMSP doing?

4.1.1 Student numbers

The number of students taking Further Mathematics in the academic year 2010-11 in these schools varied from two students taking the AS level in one school to substantial numbers in excess of 20 taking the full A level in some of the grammar schools and colleges.

Despite the variation in the types of establishment and the number of students they have taking Further Mathematics, there was a high degree of consistency in the replies to the interview questions. Many noted that numbers taking main-stream AS level and A level Mathematics have increased in recent years and this had been mirrored by an increased take up in Further Mathematics. This was largely put down to students having positive experiences with GCSE, where they were doing well and staff encouraged them to think about taking mathematics post-16. However, this was qualified in some schools by teachers pointing out that some students who think they are doing well at GCSE do struggle at AS and do not continue with A2 Mathematics; some schools are thinking that a grade B at GCSE is now not sufficient to continue with post-16 advanced Mathematics. However, many establishments pointed to their good results in both Mathematics and Further Mathematics as an incentive for Year 11 students to be encouraged to take their mathematics further.

4.1.2 Timetabling Arrangements

The timetabling arrangements for the students taking Further Mathematics vary considerably, but in many cases Further Mathematics does get a little less than full timetable allocation when compared to mainstream A level Mathematics. In some schools, where the numbers are very small there is no actual allocated timetable time, and support is offered in teachers' and pupils' own time, often supporting the tuition that is available to the students through the FMSP.

4.1.3 Engagement with the FMSP

Of these 42 establishments, 41 were registered with the FMSP, although the amount of contact with the local coordinator did vary from just receiving emails notifying local FMSP events to frequent and direct contact. Some teachers did note they would like more opportunity for direct contact and to discuss their provision of Further Mathematics with the local coordinator but time was a preventive barrier. Most though were grateful for the support from the local coordinator; for some just knowing it was available should they need it, was considered beneficial. Some teachers explained how, under the FMN, their former contact with the local Centre Manager from the FMN had been instrumental in getting Further Mathematics established in their school and they had built up their confidence to now offer Further Mathematics without so much support, but were pleased it was still available if they needed advice or some help with tuition. Some noted where they had one or two particularly able students who wanted to take the AEA Award in Mathematics or the STEP papers, that they were very grateful that the FMSP was able to direct them towards online support for those students.

4.1.4 Professional development

Most of the teachers interviewed noted that there was sufficient expertise in their departments to teach all the Further Mathematics modules that they wished to, even if in some cases this expertise resided with one or two teachers. Some teachers, particularly where student numbers were relatively large, noted how fortunate they were that their department had a large number of well qualified mathematicians who could teach a range of the modules. Many teachers supported each other within a department in their teaching of Further Mathematics, but there was also a general awareness of the need to encourage newly qualified staff into teaching Further Mathematics and that well qualified staff might well, sooner or later, leave the department.

Thus there was a need for CPD opportunities. Some teachers noted the need for new staff to have CPD input on some Further Mathematics topics whereas more experienced staff would find refresher courses helpful. Many teachers noted the difference between knowing the mathematical content of some of the topics as opposed to how best to teach it. This latter point illustrates one of the main differences between CPD offered as a face-to-face event and CPD offered via online computer based sessions using specialist software. It was noted that face-to-face events not only focus teachers minds on the event itself but also give them opportunity for interactive discussion and sharing of ideas on the teaching of topics; how to make it more interesting and stimulating for the students was brought up frequently. Online provision was thought to offer less opportunity for interaction and tended to be more instructional and topic based, although some of the online provision was described as excellent.

Many teachers, however, did note the difficulties of getting release to go to face-to-face events due to cover and other cost implications, and the attitude of senior management to this varied considerably. Against this the flexibility offered by the online provision was noted, particularly there being no need to travel and no need for cover, thus reducing costs considerably. However, there are difficulties associated with being available for a 'live' online event, with opinion split over a best time and whether daytime was preferable to post 4:00 pm provision. Some teachers thought a recording of an event would be better than no event.

The topics that teachers would like to see covered in CPD events varied considerably, some wanting pure mathematics whilst others wanted applications. There would appear to be a demand for CPD provision for the less popular modules, such as FP2 and FP3 and M3, M4 and S3, S4 and also in decision mathematics.

4.1.5 Revision Events

This same contrast between online provision and face-to-face provision is seen in the FMSP provision of revision events for students. Some schools and colleges put on their own revision events as examination time approaches, nevertheless most bring the online opportunities to their students' attention, leaving the decision whether to participate up to the students. Of those who had students who had taken up some online provision, the feedback varied from excellent to not of much use, this varying with both the topic and the presenter, though feedback gathered from students immediately

after the sessions through an online survey was overwhelmingly positive. Students who had attended face-to-face events generally found them to be very useful, appreciated input and fresh perspectives from a 'new teacher' and usually came away with a summative set of resources that they found very helpful. It was said that teachers often accompany students to the face-to-face events and get a lot out of attending themselves, this being another important aspect of CPD provision. It was, however, commented that revision events tended to be examination board specific and it needed to be made clear which board, and which modules were being covered. Some teachers suggested revision events could have greater flexibility with some topics that were common to all boards being covered in one part of the day whilst other more board specific topics were covered in another part of the day.

4.1.6 Enrichment

On enrichment, most of the schools engage their students in some sort of enrichment activities across all the year groups. The most common of these is the UKMT Maths Challenge and most schools enter pupils at the junior, intermediate and senior levels. These are often associated within school or inter local schools competitions. The FMSP is involvement in arranging the local heats of the national senior team competition was noted and appreciated. Many schools have a maths club of some sort, and have an event which focuses around maths, such as a specialism day, or on maths in use in the work place. Many teachers talked about inspiring and enthusing younger pupils and many had taken pupils to events where they thought this had happened, but this was not necessarily always the case. Some teachers suggested that FMSP could do more to support enrichment in mathematics pre-16 and help them get away from text book based provision. Similarly others thought that there could be time at the end of Year 12 for some extra curriculum input, possibly through a university, so that A level students could experience a new area of mathematics in a higher education environment.

4.1.7 Resources

Many in particular said how much they valued the MEI online resources, which are made available to teachers when their school or college registers with the FMSP, and are available to students receiving tuition through the FMSP [when schools and colleges provide Further Mathematics teaching themselves, they can choose to subscribe with MEI to obtain passwords for their students]. Words like 'brilliant' and 'fantastic' were used to describe the resources, some saying how they helped them as teachers to teach Further Mathematics well, as well as encouraging independent study by their students. Some hoped the resources could be extended to providing a library of text books and past papers for the modules where such resources are not readily available or only required in small numbers.

4.1.8 What else from FMSP?

Generally teachers interviewed are very pleased with the FMSP and what it is doing. Many talked of the high quality support available, particularly from the FMSP ACs, and they want it to continue. Teachers recognise the role that the FMSP has played in raising the profile of mathematics education and some expressed concern as to what might be the consequence if the FMSP were to be discontinued. The suggestions that teachers did make were mostly about

resources development, and further involvement with pre-16 students, such as providing mini quizzes.

4.2 Mathematics for the level 3 Diploma in Engineering

In conducting these four interviews (two colleges and two schools) the evaluator used a pro-forma similar to that for the main series of interviews, as in 4.1 above, including any involvement with the FMSP. As well as student numbers, teachers were asked about their recruitment to the course, how the students coped with the mathematics in the course, and any identified support needed for teaching staff. The responses from the two colleges and the two schools are reported separately.

4.2.1 *The colleges*

When asked about student take up, numbers appeared to be quite viable with 12 students in one college and 16 in the other taking the course in 2009/10. However, female participation was one student in each case. In 2010/11, however, one college was not running the course, whereas in the other college 19 students were currently following the course; again there was only one female student. The course was offered by the school of engineering, whereas mathematics at A level and GCSE was run in a separate academic department. It was suggested that there was some liaison between the departments, but there didn't seem to be much.

The college that was no longer running the course pointed to problems of viability and that they were unable to participate in local consortia arrangements due to timetable management problems. The teacher noted that they had been able to attract students with a sound background in mathematics and science who showed a preference for a vocational approach over the academic. This teacher had taught mathematics and he noted that the mathematics requirements of the Diploma required a different approach to academic A level Mathematics. He thought demands on the student were high, but those he had had were good mathematicians and had coped well. He thought the Diploma was a good course but noted the overall programme was complicated.

In the other college the course leader interviewed was enthusiastic about the course and noted his student numbers were increasing, but still with little female participation. Although he was unaware of the FMSP, he had heard of MEI and was planning to go to a meeting at the Royal Academy of Engineering, at which the FMSP Diploma Support Leader would be present. In delivering the mathematics he noted that staff experienced in delivering BTEC engineering had a lot of experience, but for the students there was a big change in the approach to teaching mathematics, it now being much more practically and problem-solving orientated; most students were able to cope. He noted a lack of suitable support materials that could make the mathematics relevant to students at a level they could readily access. He indicated an intention to contact the FMSP AC to investigate such support, particularly for examination preparation.

4.2.2 *The schools*

In one of the schools, an academy, the teacher was a mathematician and he had met the FMSP AC but had little time to develop any relationship vis-a-vis

the mathematics of the Diploma. The Diploma course was being developed by him and two physicists. He noted for recruitment there was a problem for Year 11 pupils in deciding between an academic and vocational path, but they had attracted well qualified students to the engineering course. This teacher too noted the change in teaching style required for the mathematics calling it a vast change for the pupils, and he would like to see the necessary problem solving skills developing from at least Year 10. In particular he compared the demands of the mathematics component unit 8 of the Diploma with A level Mathematics, noting he believed the Diploma students were being asked to cover in 60 hours the material that A level students would get 180 hours for. Regarding professional development he noted there were funding problems but what he wanted was downloadable resources that he could easily implement into his teaching. He pointed out that the sample examination supplied was very easy whereas there were questions on the actual paper the staff couldn't do! He noted the lack of time available for development work. He did however, say that the local consortium, involving three schools worked well as theirs was a small town, and timetable and travel problems for students didn't arise.

In the other school, the responding teacher was the Head of Mathematics and he knew the FMSP AC. He was developing the Diploma course with the technology department in his school, and there were two schools in the town working together. He noted the town was rural, and that if students wanted a post-16 choice they would have to travel quite a considerable distance. The number of students coming forward made the course viable, but he noted that there were budget constraints and the course was likely to be discontinued after 2012. He too noted the difficult choice faced by some Year 11 pupils; the general advice given was if you are an aspiring engineer aiming for a top university, do A level Mathematics and Physics; with the Diploma and its more practical approach being suitable for the weaker pupils. Regarding the mathematics of the Diploma course he thought the functional skills requirement was ridiculously easy, whereas the unit 8 work was very demanding on the students, particularly as he wanted them to develop some understanding of the material they were meeting, and not just apply it. He said that often it was reduced to rote learning, as there just wasn't time to develop understanding, he too noting the mismatch of time compared to the A level Mathematics course. In terms of resources, he noted the need for a practical case study approach in which the mathematics could be seen by the students as relevant to the engineering being taught; he noted the dearth of such resources, with a lot of the mathematics being taught just as results; he said it was impossible to teach the mathematics required in the time available.

4.2.3 Conclusions from the Interviews

Little can be concluded with any certainty as there were only four interviews. However, it does appear that budgetary constraints and lack of students may put the whole Diploma course in jeopardy. The teachers interviewed were enthusiastic for the course, which is doubtless why they agreed to an interview, but they did highlight the very demanding nature of the mathematics in the compulsory unit. There would appear to some sort of conundrum here, that if weaker students take the Diploma the mathematics they are asked to master is as demanding as that they would have met on an A level course, but they have less time in which to master it. There would appear to be a case for

less content and more contextualised problem solving, using mathematics that is accessible to the students and relevant to the engineering problems being studied. This is an area where the FMSP could have a developmental role.

5. Telephone Interviews with teachers from schools and colleges who are:

Delivering Further Mathematics in a consortium arrangement and / or Progressing towards delivering Further Mathematics in house

FMSP ACs across the nine regions of England were asked to supply information on schools and colleges in their area who were either delivering Further Mathematics to their students through a consortium arrangement, or were making progress towards providing the teaching of Further Mathematics themselves, rather than using the tuition services of the FMSP. This was organised through the FMSP Communications and Marketing Leader, who liaised with the ACs in seeking the information requested by the evaluator.

The information requested by the evaluator comprised:

- If a school or college regarded itself as part of a consortium, how many establishments were there in the consortium?
- If a school or college was progressing towards taking the teaching of Further Mathematics 'back in house' to what extent were they still using tuition provided by the FMSP?
- If a school or college was no longer using tuition from the FMSP, when did this first happen?
- How many students are currently (2010/2011) studying Further Mathematics at AS level and at A level?

Information was received on 115 establishments that the ACs regarded as being in one of these categories. The degree of detail in this information varied considerably, and it became apparent that it wasn't always clear whether an establishment was in the process of taking teaching back in house or were part of a consortium; in many cases it appeared to be both. Some of the ACs pointed out that for some establishments in their area, that although the intention had been to take at least some of the teaching back in house in 2010/2011, this had not proved to be possible and that those schools were still relying on the FMSP tutors to provide the teaching. It also proved difficult to give precise numbers of students studying Further Mathematics at either level in many establishments. How definitive figures might be obtained is an area that the FMSP could look in to.

Out of these 115 establishments, a sample was selected to approach for a telephone interview about the provision and management of Further Mathematics in their school or college. This sample was chosen as far as possible to have a geographical spread across the nine regions, to include schools and colleges and to avoid approaching establishments that had previously given an interview in either Phase 1 or Phase 2 of this evaluation. This resulted in 38 establishments of which 21 were broadly categorised as

being in the process of taking teaching back in house , and 17 as being part of a consortium arrangement. The request for a telephone interview was sent via email from the evaluator, but with the contact person concerned pre-contacted by the relevant AC to seek their cooperation. The target of 20 responses was achieved, comprising 3 colleges and 17 schools, and of the schools 8 were broadly classified as progressing towards taking Further Mathematics teaching back in house and 9 as involved in a consortium arrangement. It must be emphasised that in many cases there was not a clear distinction between 'back in house' and 'consortium'.

The interviews were typically between 20 and 30 minutes in duration and covered the following areas, the evaluator using a pro-forma to guide the questions and discussion.

- (a) When was Further Mathematics first offered?
- (b) What was the role of the FMN / FMSP in initiating Further Mathematics?
- (c) What are current student numbers in AS and A level Mathematics and Further Mathematics?
- (d) If growth in numbers has occurred, what were thought to be the factors driving it?
- (e) If back in house what are the factors leading to that?
- (f) If in a consortium, how is it managed?
- (g) What is the teaching / timetabling arrangement?
- (h) What recruitment activities are there for Further Mathematics?
- (i) What is done in Key Stages 3 and 4 to motivate an interest in mathematics?
- (j) Are the teaching staff qualified mathematicians; are they confident to teach Further Mathematics?
- (k) What is the view of Senior Management towards Further Mathematics?
- (l) What CPD activities have any staff participated in; what is the anticipated need for future CPD activities?
- (m) Is the provision of Further Mathematics sustainable in the future? What issues or barriers might there be as regards sustainability?
- (n) What would they like the FMSP to do to support them?

It became apparent during the interviews that each of the establishments concerned was fairly unique in the way it was offering Further Mathematics to its students, and also the issues the Mathematics Department was facing in delivering Further Mathematics. However, some points common to most could be drawn out; these were

- (a) The highly supportive role of the FMSP AC both in initiating Further Mathematics and in its continuing development.
- (b) The provision of Further Mathematics was in response to student demand.
- (c) Teachers themselves wanted to teach some Further Mathematics modules.
- (d) Further Mathematics was generally run on less timetable time than a standard A level subject, and was often not in a curriculum option block.

- (e) Timetabling constraints meant some students couldn't fit into school provision and studied elsewhere, either through a consortium and / or FMSP providing the tuition face-to-face or via online tuition.
- (f) There had been an explicit drive in the establishment to raise the profile of mathematics.
- (g) Senior managers recognised that offering Further Mathematics encouraged either current students to continue into the school's sixth form, or encouraged students to apply from elsewhere.
- (h) Sustainability is dependent on student numbers and was not certain.
- (i) Professional development needs varied widely.
- (j) The advice and services offered by the FMSP were valued and teachers wanted them to continue.

5.1 Interviews with the colleges

These points are enlarged on below. Firstly, the interviews with a teacher from each of the three colleges are used to illustrate the unique nature of provision and the environment in which it is offered. It should be noted that these are Further Education Colleges with some A level curriculum provision rather than Sixth Form Colleges where in general, the teaching of Further Mathematics is well established. It is notable that in two of these colleges the teacher interviewed was the only teacher of mathematics; in the other college there were two. It was notable that in the locality of these colleges, competition for post-16 students is high.

In one college there had been a policy to expand the curriculum from a vocational offer to include A levels. The two teachers concerned were keen to establish both Mathematics and Further Mathematics and there was senior management support. Although student numbers were still small (5 AS, 3 A2) they had timetable time and the college was no longer using FMSP tuition. Both teachers were experienced teachers at this level and were fairly confident numbers would grow in future years. It was noted that their provision was open to students from local schools if they wished.

In another college the teacher wanted to offer Further Mathematics and to teach it herself. The arrangement with the college's senior management was that she could use the premises but would actually be employed as a FMSP tutor. Further Mathematics was not in the college prospectus nor on the timetable, although she felt she had the support of the college's senior management. Numbers here were low (3 taking AS) but these students wanted to do it; both the teacher and her students recognised the value of Further Mathematics in enhancing both choice of university and its relevance to courses such as engineering with a high mathematics content. She described the local FMSP AC as having been 'brilliant' in helping her initiate Further Mathematics and she felt it could grow as the college was attracting able students; however the demise of the science department might act against this as such students might go elsewhere.

In the third college, the teaching has resorted to FMSP tuition this year because of the demand on the teacher's time. His numbers were viable (many of the students coming from an arrangement with overseas establishments) but he couldn't fit them into a timetable, despite very much wanting to teach it himself. He noted that next year he will be allowed another

member of staff who will take over some of the mathematics teaching, freeing up time for him to teach the Further Mathematics to A2 level. He noted that, as a 'lone teacher', the support from the local AC was very valuable, not least the facilitating of a 'Knowledge Network' involving teachers from other schools and colleges, which kept him up to date with the new ideas for teaching various topics. He thought that being able to offer and to teach Further Mathematics was inspiring for teachers, and he wanted his new colleague to participate in professional development for the Further Pure Mathematics 1 (FP1) module.

5.2 Interviews with the schools

Due to the inherent difficulties in categorising a school as 'back in house' or 'in a consortium', no attempt is made to do so here. Responses to the interview questions are discussed below, whilst enlarging on the points of commonality that emerged from the interviews.

5.2.1 Initiation of Further Mathematics

Some of these schools had had sporadic provision over many years, usually with just one or two students, supported by a willing teacher. However, for most being able to offer Further Mathematics was a recent innovation, brought about with support from the FMSP. The FMN or FMSP had come to a teacher's attention through various contacts or meetings. The advice from the AC in terms of managing the teaching, and availability and use of resources, was generally very much appreciated, it being noted by many that without this support the initiation of Further Mathematics in their school would not have happened. ACs generally stayed in contact with teachers either through email or personal visits, and brought professional development opportunities or revision and enrichment events for students to their attention.

5.2.2 Student Numbers

Most schools were running Further Mathematics with small numbers of students (typically 5 or fewer). In some schools they provided the teaching for AS level whilst for A2 they were going elsewhere and / or using the online resources and support from the FMSP. In many schools the teacher noted the growth in student numbers opting for AS Mathematics, and out of these, at least in Year 13, they hoped to get some good Further Mathematicians. In some schools the Mathematics Department had made an explicit drive to raise the profile of mathematics, and many noted that students coming through from Key Stage 3 were achieving good GCSE results. They liked their teacher and were confident with the teaching, and so wished to continue to study mathematics in 'their' school. However, in contrast, some teachers were concerned that a grade B at GCSE was insufficient to ensure success in A level Mathematics, noting the somewhat large dropout they experienced during and at the end of Year 12.

5.2.3 Why bring the Teaching 'Back in House'

There would appear to be two principal aspects to this; from the teachers' perspective and from that of the students. From the teachers' perspective, they want the opportunity to develop their own teaching through teaching Further Mathematics. Many are well qualified mathematicians who enjoy teaching mathematics at this level and the challenge of trying to make it interesting for their students. From the students' perspective it seemed that

many want to take Further Mathematics but in school time, and as a 'proper' lesson. Although it was noted that to begin with students were pleased to have some tuition and support even if it meant going elsewhere, or having a teaching session after close of the school day, there was now demand for provision to be on the school premises, during the school day. Teachers wanted to meet their students' needs and wanted them to take Further Mathematics because it enhanced their higher education and career options. In some schools the mutual respect and trust that had developed between teachers and students was thought to be a strong reason for students wishing to stay in school. In contrast some teachers put the view that they thought it useful for students to get some teaching from a teacher new to them, to get a fresh perspective on mathematics.

5.2.4 Consortia arrangements and their Management

There was a great deal of variation in how consortia worked. One teacher described how the FMSP AC organised it all and did much of the teaching. Her school hosts the teaching, with students attending from two other local schools. The teaching staff at the host school are currently not involved in the teaching. However, this teacher is grateful that, through her local AC and the arrangement he has helped put in place, she can give students at her school the opportunity to study Further Mathematics. Currently there are five taking AS level and three taking A2 level from her school. This consortium arrangement works well with no reported management problems. The teacher hoped that numbers would grow and ultimately she hoped the school would take the teaching back in house. The importance of Further Mathematics for keeping career opportunities open to students was mentioned by many teachers. One teacher explained how, for timetabling purposes that allowed students from other schools to participate, Further Mathematics was offered in a 'fifth option block' ; students could opt for it rather than take PSE or Critical Thinking, for example. This teacher also noted that their school's ability to offer Further Mathematics was an incentive for good students to stay in the school sixth form.

Two teachers, both from the same city (Coventry) described how they had set up consortia arrangements with other schools, but the initiative was coming from them. They thought it very unlikely that schools in the city would ever be in a position where they could all offer Further Mathematics in house, in viable numbers. These teachers wanted both to teach Further Mathematics and to make it available to their students. One teacher thought it important to retain some control over what students were doing, which was put forward as a reason for wanting to keep Further Mathematics in his school. He noted too that students benefit from regular contact with the teaching staff, which is more difficult if they are going elsewhere for tuition. The opportunity was open to students from elsewhere to come to them, but it was noted that timetable clashes and travel problems meant that the take up wasn't high. In this city there was still the option for students to attend the FMSP provision at the local university, which works very successfully.

5.2.5 Teaching and Timetabling Arrangements

It was rare for Further Mathematics to appear in the sixth form option blocks alongside other A level subjects from which Year 11 students would choose their post 16 courses, although in some schools this was the case for AS

Further Mathematics. The more common arrangement in schools where they were moving towards 'back in house' was for Further Mathematics to be 'fitted in', usually on less time than a standard A level subject. It was often grouped with enrichment type activities, such as general studies and PSE, or alternatively after the end of the school day. Year 12 and 13 students were often taught together. In some schools, teachers would offer extra support when they could and students were encouraged to use the FMSP online resources as well. This was particularly the case for students studying at A2 level. In some schools the A2 students were still being taught and supported by FMSP tutors. It was noted that generally the students were motivated to succeed and coped with the flexibility of the arrangements offered to them.

Most of the schools working in a consortium had similar arrangements and again it was rare for Further Mathematics to be a conventionally timetabled subject. However, in one school in particular the teacher explained that there was a full timetable allocation for AS level Further Mathematics, but this was part of a Local Authority drive to develop the sixth forms in the area. All the teachers interviewed indicated that they were working to get Further Mathematics established on their timetables for 2011/12, but noted this was dependent on student numbers.

5.2.6 Recruitment for Further Mathematics

In all the schools from which teachers were interviewed, students in the top sets are encouraged during Year 11, and in some schools earlier, to think about taking A level Mathematics. Further Mathematics is also brought into the discussion to ensure students are aware of it. This is enhanced through Year 11 taster days and sixth form option evenings. In consortium arrangements it was difficult to comment in general as all teachers interviewed were from the 'hub' or 'lead' school. However, it is also apparent that some students in Key Stage 4 are aware of Further Mathematics and enquire about taking it post-16, but just how much information is available to them in some schools is not clear. It is also notable that in many schools, students who are currently studying A level Mathematics in Year 12 make a decision to study AS level Further Mathematics in Year 13.

5.2.7 Motivating an Interest in Mathematics in Key Stages 3 and 4

This varied considerably between schools, from some where there is little or no enrichment activity to those where puzzle clubs and similar are run to motivate mathematics as fun and challenging. Many schools have some sort of enterprise day in which pupils see applications of mathematics in use in 'business'. Most schools participate in the UKMT junior and intermediate challenges, both the paper based one and the team challenge, although this does seem somewhat sporadic year on year. Some schools involve their gifted and talented Year 9 pupils in the Royal Institution's Master Classes. In some schools they make use of online provision such as the 'MyMaths' website. Some schools have taken Key Stage 3 and 4 pupils to enrichment events put on by the FMSP or similar organisations, again promoting mathematics as both fun and challenging and offering insights into the subject pupils are unlikely to meet in the classroom. Some take pupils to visit local places of interest where mathematics has a high profile, such as Bletchley Park for code breaking, or there were connections with local industry. Most

teachers said they would like to do more in the enrichment area but time and budgetary constraints prevented this.

5.2.8 Teaching Staff and Ability to Teach Further Mathematics

All the schools had at least one teacher who was a qualified mathematician, and in most schools more than one member of staff was involved in its delivery. In some consortium arrangements though, no member of staff at some schools were involved in the teaching. Often the applications modules, mechanics, statistics and decision mathematics would be taught by the teacher most comfortable with it, or one of the applications might just not be offered as an option. Teachers were generally confident about teaching the AS modules of Further Mathematics but less so about the A2 modules, particularly those in pure mathematics. One teacher commented that she thought it good for younger students to be aware that their teachers were teaching at this level, as this might raise their own expectations. Some teachers mentioned less experienced teachers who first needed to build confidence and expertise in teaching A level Mathematics before developing into teaching Further Mathematics. Some teachers mentioned the vulnerability of their provision if an experienced member of staff left the department.

5.2.9 View of Senior Management towards Further Mathematics

In general, the ability of a school to offer Further Mathematics is seen as beneficial to the school. That is if a school can offer Further Mathematics then students in Years 10 and 11, who are thinking about their post 16 options, might well stay on in their own school's sixth form rather than be enticed elsewhere. Keeping and attracting good students is clearly of importance to school management, particularly where they want to develop their sixth form provision. Further Mathematics was often allowed to run with a small number of students, in a group size that in another subject would be deemed non-viable. In contrast however, many teachers mentioned the dilemma of schools' senior management in wanting to fund Further Mathematics but feeling they are unable to unless numbers are 'viable'. In a time of budget cuts and constraints this could prove even more difficult in future. In some schools it was felt offering Further Mathematics was not a priority for the schools' senior management and it has been 'a bit of a battle' to keep it going.

5.2.10 Professional Development

Professional development needs were seen to vary widely. These vary from schools and colleges where it is considered that they do not need any at present to those where teachers perceive the need but are not currently participating, to those who welcome the opportunity to go on 'refresher courses' and work with like minded teachers from other establishments. One teacher noted 'there is always room for training and support'. Some of the teachers who are confident in their teaching and knowledge of mathematics required at this level acknowledge the value of refresher courses and the opportunity to share teaching ideas and resources. Ideas for motivating the students and making the mathematics more interesting were particularly welcomed. The needs of teachers new to A level teaching were recognised, including the need to build their knowledge and develop their confidence to teach Further Mathematics.

If they were to participate in professional development, most teachers noted a preference for a face-to-face event where they would be focussed on what they had gone to do and that it was good to create networking opportunities with other teachers. As one teacher said; 'there is no substitute for meeting others'. Those who had been to a recent event, or a had a colleague who had, generally regarded it as a day well spent, coming away with resources and ideas for use in their classroom. However, the difficulties of 'getting out of school' were noted by some, and that online provision did give opportunity for professional development when teachers cannot attend courses during the school day. In some schools it was noted that the teachers who had attended a revision day for students benefited in terms of professional development.

5.2.11 Sustainability and Barriers to Sustainability

In all the schools there is uncertainty concerning their ability to sustain provision of Further Mathematics with confidence. However, in most schools there is optimism and they hope that student numbers will grow. Many teachers mentioned a growing interest from Year 11 students, as they become more aware of Further Mathematics and how it can enhance their career opportunities. It became apparent that sustainability is very dependent on student numbers, and that senior managers will keep the situation under review. A general problem for schools is that they want to give definitive assurance to their Year 11 pupils that Further Mathematics will run in the school, to try and prevent students leaving, but are not in a position to guarantee it. Some teachers working in consortium arrangements thought they would retain viable numbers as long as the consortium kept going. Attracting students and then being able to offer teaching and support in a similar way to other subjects, was thought to be crucial to retaining them. It was also noted from both a senior management perspective and that of potential students, that Further Mathematics will look much more sustainable if current students achieve good results.

5.2.12 FMSP Support

All the teachers interviewed acknowledge the proactive role of the local FMSP ACs in initiating and developing Further Mathematics provision in their school. As well as the initial help and advice in setting up the course, the ongoing support was welcomed, as was being kept informed of local events in terms of enrichment and revision opportunities for the students. The phrase 'the support is fantastic' or something similar was used by many teachers. Many just wanted 'more of the same', and felt that they were just pleased that the FMSP 'was there' if they needed it. For some, if they ran into tuition problems on a particular module or for particular students, they could confidently expect FMSP tutors to fill the gap. Many mentioned their own and student use of the FMSP online resources and the 'integral' website saying these were very useful, and they would like to see them go on developing. Some mentioned that they would like to see the development of forums, both for students and teachers. These forums actually already exist and the FMSP should consider making schools more aware of them. One teacher who said he was from a traditional working class area, said he would welcome advice on raising the aspirations and broadening the horizons of his pupils as to just what was 'out there'; they needn't just opt for their local university. He asked for help in STEP. So this is another area that FMSP might think about targeting in terms of advice and information. Another teacher asked if FMSP had any 'strategies

for growth'; could they offer advice for influencing the post-16 decisions of younger students?

6. Professional Development

The FMSP offers a wide range of professional development opportunities for teachers both of A level Mathematics and Further Mathematics. Professional development is available either through events, typically one day on a particular module or topics from a module, or through longer courses. The evaluator observed a one day event on topics in Further Pure Mathematics which is reported on below. There is also a course that lasts for fourteen months, the 'Teaching Further Mathematics (TFM)' course that can lead to a higher degree in mathematics education; this is reported on below including a visit by the evaluator to a day school from the programme. The other form of long course is provided online using the virtual classroom software 'Elluminate'. These Live Online Professional Development (LOPD) courses, typically last for 10 weeks with a 90 minute session each week in a regular slot. The evaluator 'sat in' on two of these sessions on a particular topic in Further Pure Mathematics 2, as well as sampling some recordings of other sessions; this is reported on below.

Information about professional development opportunities is well publicised on the FMSP website, both in general and for each region; each region has its own web page where the FMSP ACs can give specific detail of their provision. Registered schools and colleges are also kept informed of events through email contact by the local FMSP AC.

6.1 CPD Day Event

The evaluator attended a training day on the module Further Mathematics 1 (FP1). The event was held in January 2011. The evaluator had difficulties finding an event to attend because the adverse wintry weather in November and December 2010 led to many cancellations, and there are relatively few opportunities in the winter months compared to the summer anyway. This is principally due to difficulties teachers can experience in getting release from school. It is easier in June and July, when Years 11 and 13 have usually gone on study leave. There were six participants at the event in January, which emphasises the problems teachers can have in attending term time events, as more were expected but dropped out; typically at summer events there might be 20 participants.

A full day programme on various topics from the AS Further Pure 1 module was delivered to these teachers. Although the event was held in a school, a classroom was used that was away from the main buildings so there was no disturbance from the rest of the school. The room was well organised with the furniture arranged to facilitate discussion between participants but also so that they could easily see both the Interactive White Board (IWB) and the marker pen board, which the two tutors made good use of. Tuition was provided by the local area FMSP AC and the FMSP Professional Development Leader.

The morning was broken up into three sessions of about 75 minutes each on different topics. In these sessions the tutors discussed how the topics might

be introduced to students, gave suggestions for developing students understanding, but also made participants aware of the type of examination questions that their students would ultimately be required to answer.

The first session was on the topic of conic sections. The tutor emphasised that although ultimately examination questions on this topic were algebraic in nature, students generally had problems with this abstract nature of the topic. She advised that for students meeting the topic for the first time, a visual approach was preferable. She also emphasised that as conic sections are essentially planes cut through a 3-Dimensional cone, such a cone is also a very useful aid to visualisation. The tutor demonstrated several visual ways of looking at conic sections on the IWB, suggesting websites where further resources could be obtained. She pointed out common student misunderstandings as she did so and how these might be overcome by encouraging students to investigate conic sections using the software. She emphasised again how visualisation leads to understanding. The tutor then presented some typical examination questions and invited discussion on how to approach them, especially bringing in alternative approaches that students might take. She handed out some further questions for participants to have a go at and discuss with each other; she did supply the answers as well. This session ended with a general discussion of how the topic, conic sections, might be motivated for students with some 'real life' examples.

The second session on numerical methods with the other tutor, contrasted well with the first. He supplied a handout of the PowerPoint slides with which he introduced the topic. He motivated the topic by introducing some equations which can't be solved by analytic methods, and then outlined the three techniques required in FP1, but advised of the need to do some preliminary graphical and numerical exploratory work with students before moving to these more formal techniques. He noted the opportunity to use spreadsheets to take the tedium out of calculator based searches and also how graph plotting software could give students insight into what solving a particular equation entailed. He advised participants to be wary of introducing the formal iterative formulae by which these techniques work, as these can be very confusing to students. He advised keeping it relatively simple, noting that in examination questions, typically only one iteration is required. The tutor gave the participants several questions to practice with, again stimulating discussion amongst them as to differences and effectiveness of the different methods available. In ending the session he brought to the participants' attention that more examples were available on the FMSP 'Integral' website.

After a break, the third session was on rational functions, illustrating the variety of topics that comprise this module. The tutor explained that in graphing these functions, examiners will expect to see evidence of a systematic method, and there would be little credit for what students might see on a graphics calculator. She illustrated through examples how these graphs might be built up in stages and how this might be done in discussion with their students. She emphasised again the interplay between visualisation and the algebra involved and how this could help students overcome misconceptions and common errors. The participants were then given some active learning examples for them to work on and discuss. There was also an activity which the tutor recommended for classroom use involving matching

graphs to their equations with both graphs and equations on sets of cards, which encouraged discussion along the lines of 'why it can't be this one', but 'it could be that one'.

After lunch there was a session on the topic of roots of equations. Again the tutor gave an overview of what the topic was about and put up some examples for discussion, before giving the participants some typical problems to work with and discuss. This was followed by another card based matching activity, in which the challenge was to match the expression involving the roots to its associated quadratic equation. This promoted sharing ideas and teamwork and required a lot of accurate mental arithmetic. Here too the participants were experiencing for themselves an activity they could use with their own students. The tutor then demonstrated the extension of relationships between roots into cubic equations and discussed the pattern continuing into quartic equations challenging the participants to write down their expected results, and left them with an intriguing puzzle concerning the roots of cubic equations.

The final session was on improper integrals. This involves the concept of infinity, which many students have difficulty understanding. The tutor again suggested how the topic might be introduced before the more formal requirements of the FP1 specification were met. He illustrated the idea of infinity using a 'story' about a hotel with an infinite number of rooms asking can it ever be full? This too is an idea that might be used in class. He went on to illustrate some of the common misconceptions in the relationship between nought and infinity before discussing some actual improper integrals, and discussing the notation students would be expected to use in answering examination questions. He gave out a hand-out with some practice examples. The tutor ended the session with a discussion of differentiation from first principles, again emphasising the difficult points that students may encounter with this. He discussed whether the general case of the derivative on x^n should be discussed with students, suggesting further mathematics students should have some appreciation that results they are familiar with can be proved rigorously. He related the proof to the binomial coefficients in Pascal's Triangle, and ended with showing what a wealth of mathematical sequences are present in the Triangle, which might be a good piece of extension work for students to investigate.

Participants left this professional development event with an attendance certificate and a lot of ideas to try out with their students and a number of resources for FP1 but also including some mathematical puzzles they could entertain themselves, or their students, with. They certainly seemed to have had a very purposeful but enjoyable day.

6.1.1 Feedback from Participants at this event

As is the usual case with FMSP professional development events, the participants were asked to complete an end of event evaluation form (these are discussed further below, in the light of a wider range of events). For this particular event, there were five such forms (one participant had to leave early), in which the participants showed they were very positive about the event. With one exception they found the course content good or excellent. One teacher was critical of the advance information, saying that topics she

hadn't been expecting were touched on and she wasn't prepared for them. Participants gave as the most useful aspects of the day, the time to discuss methods and problems, the resources, being able to talk with other colleagues and share ideas, and actually doing some mathematics. On what could have been better, apart from the one criticism above this was left blank, or as one teacher put it, 'none – both courses for FP1 have been excellent'.

6.1.2 Feedback from Participants at all Professional Development Events

At the end of every professional development event where teachers meet with tutors for face-to-face input and discussion, the participants are asked to complete an evaluation form that the FMSP has standardised for all such events. (See Appendix 3). These provide feedback in the first instance for the tutors and the AC who organised the event to inform their planning for subsequent events. The ACs are asked to forward the evaluation forms to the FMSP Office where they are summarised, if the AC hasn't already provided a summary. In this way a central record is maintained.

Copies of these summaries were made available to the evaluator. They covered a range of events across the country and all the core pure mathematics modules in Mathematics and Further Mathematics at both AS and A level, and most of the application modules. There were other types of events as well, such as using IT to enhance teaching. Though there is a standard FMSP feedback form, these had not always been used. As a result the summaries hadn't all been completed in the same way, and it wasn't possible to aggregate the data so that a national picture across all the FMSP professional development of this type could be obtained. This is something that the FMSP might like to address; ensuring standard feedback forms and summaries are used, so that aggregation is possible, either for all events or subsets of events by topic or region or other classification.

However, it was possible to discern an overview of the feedback just from reading the summaries and looking at the data they contained. The number of participants varied widely but most were well attended with around 20 participants, although some were much smaller than this, the smallest being two participants.

In the first six questions on the evaluation form the responses were overwhelmingly 3s and 4s, indicating participants had found the various aspects of the event at least good, if not excellent. Where there were 2s and the occasional 1, indicating a poor aspect of the event, it tended to be because of the refreshments provided or the suitability of the venue, and occasionally the organisation and information received in advance of the course. In general the course content and standard of delivery were found to be at least good, with some exceptions for individual teachers. Relatively few teachers wrote anything in the comments section of the first six questions, but it was generally qualifying their choice of numerical response. This is information that should be particularly useful to event organisers and presenters.

In the open questions on the evaluation form, there was a wide variety of comment made by teachers who attended the various events, but some commonality can be drawn out. On 'what were the most useful aspects of the

day', teachers mentioned the enthusiasm of the presenters enthusing them, the ideas and teaching tips put forward and shared by the participants and the resources made available and information on web based resources. Teachers new to a module mentioned the benefit of getting an overview and developing their understanding of topics and teaching ideas whilst the more experienced appreciated the advice on examination preparation and what examiners were looking for. On 'what changes would you suggest we make when planning future events' the most common theme was time, some participants would have liked more time spent on some topics or more time spent on activities. Some thought too much material was covered and would have liked the event more focussed. However, it is difficult to generalise from these summary forms and it is hoped that this feedback on particular events to the organisers and presenters has been acted on when planning subsequent events. On 'any other comments', the comments were generally positive with most participants saying they had got a lot out of the day and were grateful for being there and could they have more of the same for other modules. There were some particular suggestions, like can we have more group work. Some participants mentioned pre-requisite knowledge, some saying they hadn't actually learnt anything new whilst others suggested they could have been better prepared had they had a better idea of the event content.

6.2 Professional development, telephone interviews

Through the Communications and Marketing Leader at the FMSP Office, the evaluator requested contact details for a sample of participants who had attended events. These were supplied by some of the ACs and the evaluator selected a sample to cover a range of events and a geographical spread. Twenty teachers were approached for a telephone interview of whom eight responded positively.

In conducting the interviews the evaluator used a pro-forma which covered the following questions.

- (a) Why did you participate in this particular event?
- (b) What were your expectations; were they met?
- (c) What was good; what could have been better?
- (d) How has attendance affected your teaching?
- (e) What were any sharing or dissemination arrangements with colleagues?
- (f) Any future plans as regards professional development?
- (g) Are there any barriers to participating in future events?

6.2.1 *Why participate in the event?*

There were essentially two reasons for participating. Some teachers were teaching a module for the first time and were looking for reassurance they were approaching it properly and generally looking for advice on how to teach topics. Others were looking for a refresher course because they hadn't taught the topics for some time.

6.2.2 *What were your expectations; were they met?*

The teachers felt that the information they had received in advance of a course was good, showed them what to expect and generally this had been achieved. One teacher, in reference to the Decision 1 event he had attended

noted he got a lot more out of it than he had expected; he said he really enjoyed it and that it had saved him a lot of time in that he didn't now need to 'teach himself'. Another teacher, who had also attended a Decision 1 event, said he had heard some negative things about Decision Mathematics and was pleased to find there was some 'proper mathematics' and he got a good idea of what the module was all about and ideas for teaching it. In contrast, another teacher who had attended an event on Mechanics 2, noted that the whole course hadn't been covered and there were topics she would have liked some input on. She did however acknowledge the difficulty of trying to fit everything in to one day.

6.2.3 *What was good / what could have been better?*

Teachers were generally very positive about the event they had attended. Some talked of how it had built their confidence to teach topics, it had confirmed their own understanding as well as given them ideas for introducing topics to students. Resources were commonly mentioned and particularly using them themselves as activities, getting hands on experience of how their students might react to the activity in class. Two teachers did mention that the Further Pure events they had been to were a little dry in terms of exposition and perhaps more interactivity could have been included, but for most the balance between exposition and activities had been about right, as was the pace of the event. However, all the teachers were grateful for paper based resources supplied to them or electronic ones on memory sticks as well as being shown what was available on a range of websites. Many said they had already used some of these successfully with their students and were pleased that they could now broaden out away from the textbook with confidence.

There were no negative comments on what could have better, bar lunch arrangements in one case. Most were impressed with the enthusiasm of the presenters, it had rubbed off on them and they thought attending the event had been very worthwhile.

6.2.4 *How has attendance affected your teaching?*

The teachers were either teaching a module for the first time or after not teaching it for a while and all were making use of the resources or teaching ideas they had met at the event.

6.2.5 *What were any sharing or dissemination arrangements with colleagues?*

Two of these teachers were from schools where there were relatively large numbers of students taking Further Mathematics, and they were pleased they were able to share the ideas and resources they had learnt about with colleagues. This tended to be both informal and more formally at a departmental meeting. One teacher noted how it had emphasised for him that his department doesn't generally discuss how to teach topics in A level Mathematics, but that they should. In other schools with smaller numbers of students only two or three teachers were teaching Further Mathematics; however those that had been to a Further Mathematics module event did share the resources and discuss the day with their colleagues, including how they might develop their teaching to support their students and anticipate misunderstandings.

6.2.6 Any future plans as regards professional development?

All these teachers were keen to do some more professional development. Those who had done the Further Pure 1 module wanted to extend this into the A2 modules. Those who had been to events on the applications module said they wanted to go to other events, or would encourage colleagues to go. Two teachers noted they were interested in taking the Teaching Further Mathematics (TFM) one year course and had management support to do so. One teacher noted this in respect of senior management wanting to ensure the school could continue to offer Further Mathematics. One teacher noted he was keen for a colleague to take the Teaching Advanced Mathematics (TAM) course, as he wanted to develop teachers' ability to teach A level Mathematics. All these teachers would recommend to others the benefit of attending a professional development event. Two teachers mentioned in particular how impressed they were with not only the professional development, but the FMSP activities and resources in general.

6.2.7 Are there any barriers to participating in future events?

The above shows the general enthusiasm of these teachers for professional development, but they were well aware of constraints. Although they all said that senior management was supportive, with two mentioning its role in school development plans, budgetary constraints might be an issue. However one teacher had noted he thought the event he had attended was very good value for money. The other constraint is time; some teachers are reluctant to leave an examination class or are just not permitted by management to do so. Two teachers noted they were fortunate in the date of their event; one was able to go because the school was off timetable that day, and for the other it coincided with her day off. In contrast one teacher noted that if the professional development was relevant to the school's development plan, there would not be a problem with being released.

6.3 Live Online Professional Development (LOPD)

Live online professional development (LOPD) is an alternative professional development opportunity offered by the FMSP to face-to-face one day events. These are computer based and use the virtual classroom software 'Elluminate'. This software allows for 'remote' tuition and for the participants to be anywhere in the country, as long as they can log into the same 'classroom'. Participants can't see each other or the tutor, but audio contact is available via a microphone and headset, and participants can also communicate through a 'message box'. All can see and contribute to an online Interactive Whiteboard using a graphics tablet.

The LOPD opportunities are courses as opposed to events typically lasting 10 weeks with weekly evening sessions of 90 minutes, usually from 4:30 to 6:00 pm. The LOPD offered most of the modules in A level Mathematics and Further Mathematics or at least a range of topics from them. These were advertised on the FMSP website. Numbers were limited to at most eight participants to encourage interaction between participants. In 2009/10 55 teachers followed a LOPD course. A LOPD course in the mathematics for the Engineering Diploma was offered but there was no take up. During the current academic year (2010/11) take up has grown considerably, with 68

teachers attending courses in the first half of the year and a further 52 attending courses currently.

The LOPD sessions are recorded so that the participants can replay them, but interaction is only possible if the session is live. The evaluator sat in on two live sessions on one of these courses to experience what the participants were getting from it, and also sampled some of the recordings. For the live sessions the evaluator deliberately chose one of the more demanding FP2 topics.

6.3.1 Experience of the Live Session – topic from FP2

This course had five participants and took place between 4:30 and 6:00 on a weekday evening. There were some initial technical problems but the presenter ensured everyone could hear and was properly connected before beginning. The evaluator found joining the 'class' to be every straight forward using the information the presenter had supplied.

The presenter firstly gave an overview of what she was going to present in the two sessions, using prepared PowerPoint slides which were clear, and in particular showed how these topics fitted in with various examination board specifications. She then started introducing the first topic using a mixture of prepared slides and actually doing it live on the IWB using a graphics tablets. The exposition was very clear but the presenter checked with the participants that were following and understanding, something she did throughout the session. Following the introduction the participants were invited to contribute their solutions to some problems via the graphics tablet, allowing for interaction and within the limitations of the technology, some discussion. In graphical work in particular the presenter emphasised sketching graphs by hand which the participants had done, and then tidying this up using a graphing software package. She recommended this was the way to develop this topic with students. She also illustrated how the topic they were studying related to other topics in FP2 and indeed to topics from main core pure mathematics. This would give students opportunity to experience the coming together of what at first would appear to be disparate ideas. She gave the participants several problems to work on before sharing their solutions with each other; it was noted that there was often more than one way to solve problems of the nature concerned. The presenter continued in this way, with a mix of exposition and inviting active participation, whilst checking that that they were all 'happy' and following the development of the topics. If participants made a mistake, these led to useful discussion. The presenter was extremely well prepared and was able to illustrate where common student misunderstandings occurred and also where there was opportunity for some extension work. She noted that for examination purposes several of the results that students need are provided in the formulae booklet, but she emphasised it was good for students, and their teachers, to see how such results are actually derived. She noted how students would develop a better understanding through graphical approaches to some topics but that ultimately in an examination they should be able to use the result from the formula book. At the end of the session the presenter invited questions, but there were none. This was not surprising as it had been an intensive 90 minutes work, which for the teachers was probably at the end of a teaching day.

The second session was handled by the presenter in a similar way to the first session, only she started by reviewing what the participants had met last week. The participants were again introduced to particular aspects of the topics, using exposition before looking at typical problems which they could participate in solving. The presenter again noted the use of the formula book and that students should not try to memorise results, but know where to find them. In closing this session, the presenter gave notice of what was planned for next week. This session would focus on sharing of resources, and the participants were invited to bring along any resource they had found useful, but in an electronic form. The presenter also reminded the participants about all the support resources that were available on the FMSP 'integral' website. Apparently this session on sharing resources is the way all the 10 week LOPD sessions end. As a different presenter was to do the resources session, this presenter bid the participants farewell, but invited them to stay in touch and contact her via email or other means should they have any queries.

6.3.2 Recorded LOPD Sessions

The evaluator only 'dipped into' some of these across a few topics, but it was notable that the form of the presentation was the same. Clear exposition using pre-prepared slides and then what at the time would have been live interaction opportunities with the participants encouraged to take part. The pace of delivery in all cases seemed about right.

6.3.3 Feedback on LOPD

Teachers who have participated in a LOPD course are asked to complete an evaluation form at the end of the course. This form is available to the teachers online. It is a somewhat different form to that used for face-to-face professional development in that venue and catering questions are irrelevant, but more detail is sought about the administration and delivery of the courses. Teachers did make some criticism and put forward suggestions for improvement, but in general the feedback was very positive and teachers had achieved what they had hoped for though taking a course.

The evaluator was able to interview two teachers who had taken a LOPD course, one on FP1 and the other on topics from FP2 and 3. The interviews were conducted using the same pro-forma as for the face-to-face one day events.

The teacher who had taken FP1 explained how she was renewing her acquaintance with A level Mathematics as it was being rejuvenated in her college. She took the TAM course last year, and was made aware of opportunities in Further Mathematics, including TFM, but wanted to take the FP1 course as she was currently teaching the module this year. She noted that there was a lot of material for the presenters to get through and there was a lot of exposition with only limited interaction, but none the less it was a lot better than using a textbook to try and teach herself. Although she liked the opportunity to work on her 'own screen' when set a problem she would have liked more support; it was noted that this was a limitation of the software. She did however get ideas for her own teaching, and some resources such as spreadsheets. She now feels comfortable with most of the mathematics, but noted she was still found some of the topics confusing. She mentioned

complex numbers and roots of equations, but did note this may be because after 6 hours teaching, she was tired when trying to take in these topics. She did, however, think 4:30 was the best time of day for the sessions as she could do it at the end of the college day. She felt generally that participating in the LOPD course had been worthwhile; she now felt confident to broaden out and not be dependent on the text book. She wants to do more professional development work in Further Mathematics and particularly would like to take the TFM course, but noted the budgetary constraints in the college. She also has a colleague new to A level teaching who she would like to take the TAM course and follow a similar professional development route to her own. She noted that senior management are generally supportive of this, as in the locality of the college there is a lot of competition for post-16 students, and that offering Further Mathematics attracts able students to the college. They have a small number of students taking AS Further Mathematics this year but she has been assured that the AS course will run again next year, and she wants to support students who wish to stay and take some A2 modules. Finally this teacher did suggest that FMSP consider two courses, one where participants have no previous knowledge of the topics so they are learning it, and another in which more experienced teachers can gather ideas and strategies for teaching topics.

The teacher who had topics from FP2 and FP3 wanted a refresher course for although she had met these topics before, it had been a gap of many years since she last taught them. She liked the idea of a 10 week course in which she would focus for 90 minutes a week on the topics. She felt she just would not have done this had she tried to just revise from a book. She found the two presenters on the course to be very clear and worked in a very friendly and encouraging manner. There was a good mix of exposition and activity but she did note she would have liked more on how to introduce the topics with students and for teaching strategies. She is currently teaching both FP2 and FP3 and is confident in her teaching. Her only real criticism of the course was of a technical nature; of the five participants only two had microphones, which limited the interactivity and discussion. She thought overall taking the course had been a worthwhile experience. She noted that she works in a successful department in a sixth form college where student numbers are high, and that most of the staff teach some Further Mathematics. They share classes and rotate the modules that they are teaching to try and keep themselves up to date with topics and the teachings skills needed. However she did recognise the benefit of regular professional development, particularly for new teachers. She noted there were two new teachers at the college now teaching A level Mathematics who would benefit from being introduced to topics in Further Mathematics and their teaching through professional development courses. She said her senior management team were generally supportive of professional development, but there are of budgetary constraints that all currently have to work within.

6.4 Teaching Further Mathematics (TFM) Study Day

The Teaching Further Mathematics (TFM) course offered by MEI provides an extensive course of professional development for teachers of A level Mathematics who are now teaching Further Mathematics, or wish to teach it at some point in the near future. The course covers material from all Further Mathematics specifications, with emphasis on expanding the participants'

mathematical horizons and giving them a deeper understanding of the links within mathematics. The course takes fourteen months to complete, and can contribute to a master's degree accredited by University of Warwick. An evaluator attended the first session of the course for 2010-11 to observe the proceedings and to discuss with participants their reasons for taking this course and their expectations.

The first 'Study Day' associated with the current TFM course took place at Warwick University in October. It was attended by 21 of the current 27 participants signed up to the course. The number of participants is fairly evenly balanced by gender (11 male, 15 female), with age ranging from 20s to 40s. Some of these participants had come relatively late into teaching, having had various mathematics related careers before entering the teaching profession. They were finding the course demanding, but were managing and were grateful for all the support that was available to them. Most were currently teaching, or had taught, at least one Further Mathematics module.

The study day was led by the Professional Development Leader and the Student Support Leader from the FMSP. The programme for the day was intensive, and started with a presentation from the Professional Development Leader who put the TFM course in the context of the broader aims of the FMSP, and illustrated this with figures on the growth in number of students taking Further Mathematics in recent years. She then 'broke the ice' with a warm up session inviting the participants to tackle and share some problems in complex numbers, which they had come prepared to do. This appeared to be very successful with participants sharing and discussing their results. This was followed by showing the participants where and how they could get further support for the TFM course and outlining the course requirements and where various web based support resources are located. There was clearly considerable support available to these participants, not least by direct email to the Professional Development Leader.

The second and third sessions of the Study Day were taken by the Student Support Leader. He gave a presentation about the Further Mathematics topic of matrices, giving the participants lots of ideas to follow up with their students, particularly in practical applications which students might well have encountered, such as how does the internet search engine *Google* work? The Student Support Leader also took the third session focussing on proof, again giving the participants lots of ideas on how to approach the teaching of topics that students often find difficult. In the last session of the Study Day, participants worked together in small groups on problems from Further Mathematics, given to them in formats that they could use with their own students if they so wished. This was very interactive and discursive and all participants seemed positively engaged with what they were doing. They certainly had resources to take away with them, including text books for the remainder of their TFM course.

The evaluator asked some of the participants what they had got out of attending the Study Day. To meet with other participants on the course was welcomed, and the presentations on the Further Mathematics topics, both the content and ideas for teaching them, were much appreciated.

6.5 Further Mathematics Knowledge Network.

Further Mathematics Knowledge Networks (FMKN) are becoming established across the country. The FMKNs have two main aims. Firstly FMKNs aim to help teachers develop their own knowledge and understanding of mathematics. Secondly FMKNs aim to help teachers develop their knowledge and understanding of the pedagogy of mathematics teaching and to facilitate putting ideas into practice in the classroom, particularly in the teaching of topics from Further Mathematics.

The FMKNs aim to support both experienced and new teachers of Further Mathematics by facilitating the sharing of resources and discussion of good practice in the teaching of Further Mathematics topics. These teachers will then in turn have knowledge and materials available with which to interest their own students in the mathematics and hopefully inspire them to pursue a higher education course and ultimately a career with a high mathematical content.

The FMKN meetings of teachers thus complement other aspects of professional development provided by the FMSP, with the emphasis on sharing and developing ideas together. One FMKN is well established in the North West of England and the evaluator observed an FMKN event held in that region. The event had been organised by one of the North West FMSP ACs. The theme of this meeting was the use of a graph drawing software package in the teaching of mathematics. The meeting was led by the other North West FMSP AC, who was an expert in using this software. Participants had been asked to bring a laptop with the software ready loaded so that they could take an active part in the event, rather than just observe. There were ten participants present on a weekday afternoon, from schools and colleges across the region.

Some of these participants had used the software before and had developed some experience whereas for others this was their first time of seeing it. The presenter explained that he was going to demonstrate ideas for classroom use both within Further Mathematics and beyond, noting that the software invites exploration and for students to find things out for themselves and that it was important for teachers to experience this for themselves. There would be plenty of opportunity during the afternoon for 'do it yourself' and to explore further. The event was broken up into three sessions, the first introducing the software and its functionality, with the second and third sessions then focusing on its use in the FM modules Further Pure 1 and Further Pure 2. There was a handout to support each session.

In the first session the presenter illustrated the basic software controls, but also its versatility, and in particular the ease with which it was possible to return to the starting point if something had gone wrong. Participants were then given a series of tasks to work on using the software, with support available from the two FMSP ACs as well as each other. A particularly good challenge involved a handout of some graphs for participants to reproduce on their computer, which created considerable discussion over what the relevant functions might be. It was noted that this had a lot of potential for use in the classroom. A second activity in the first session focused on the software's ability to illustrate transformation geometry, and how this could bring in the

Further Mathematics topics of matrices and matrix algebra, and could be extended to visualisation of the FP4 topics of eigenvalues and eigenvectors. Most of the participants were replicating on their laptops what the presenter was showing them on the IWB. There was a series of tasks for the participants to have a go at and explore for themselves the affect of various matrix operations on the transformations.

The second session was aimed specifically at some FP1 topics and how visualisation would help develop students' conceptual understanding of these topics. In particular the presenter demonstrated how the 'zoom' facility of the software gave insight into what was really going on in the iterative Newton Rhapsion method of solving an equation, which he feared many students were taught as a technique with little or no understanding of why it worked. The ideas of convergence and divergence were also brought to life using the software. The presenter again gave the participants opportunity and time to explore these ideas through tasks which they could discuss with each other, and with support from the two ACs. He also brought to their attention websites where further ideas for activities and resources could be obtained. He illustrated the fun aspect of such a resource by raising the question what shape is a human face, starting with 'importing' a face and discussing symmetry, before relating this to conic sections and the manipulation of an ellipse to a correct looking shape.

In the third session the participants were introduced to how the software could be used in various aspects of teaching topics from FP2 such as polar coordinates. He also showed how the software was very versatile in its representation of 3-dimensional shapes, and how this could be used to enhance students' understanding of volumes of revolution. He also demonstrated other aspects of 3-dimensional topics, illustrating for example how the software could help students understand the difference between a line and a plane in 3-dimensions. He noted in closing how it was fun to create shapes by using, for example, cylindrical polar coordinates in 3-dimensions and just manipulating them; a great opportunity for students to have some fun creating interesting shapes whilst pondering the mathematics of their manipulation. He challenged the participants to produce a 3-dimensional 'work of art'.

The evaluator certainly found this an enjoyable and stimulating event. He worked with several of the participants, himself discussing what they were doing and its potential for the classroom. The evaluator felt that the participants would go away from this event with not only a good knowledge of the software, but more so ideas and resources which they could take back to their schools and colleges and develop further with their colleagues and their students.

In closing the session the organiser explained how they were trying to build up the Knowledge Network, encouraging teachers new to FMKN to come along, as well as welcoming back regular attendees. The organiser noted that the FMKN wanted to respond to teachers' needs in terms of teaching, but more so wanted to facilitate and encourage discussion on why it is important to teach Further Mathematics and to encourage students to study it. The participants present at this event certainly seemed to support such an aim.

6.6 United Kingdom Mathematics Trust Team Challenge

The evaluator attended a regional heat of the FMSP/United Kingdom Mathematics Trust (UKMT) Senior Team Maths Challenge. This is a team competition between schools for pupils from Years 11, 12 and 13. Each school enters a team of four pupils, of whom two at most can be from Year 13. The event attended was one of two regional heat events being staged in North East England. There were about 50 such heats across England, with some in the other parts of the UK as well. The regional heats and the whole competition are organised jointly by the UKMT and the FMSP. Teams can enter via the FMSP website, where further information and examples can be found of the sort of mathematics involved in the challenge.

In this particular event there were 28 schools represented, including four from the independent sector. These schools represented a wide geographical spread across the region, with some schools travelling a considerable distance in order to be present. The event took place in the main hall of the host school. This was spacious and well organised so that each team could easily find 'its table', having been welcomed at the entrance by the FMSP AC on their arrival. The event was formally started by a welcoming speech by a member of the senior management team of the host school. The organiser from UKMT then explained to pupils and their accompanying teachers how the event would work in terms of the rounds and the assessment of each team's work. Teachers did not mark their own team's work, but would mark that of another team. The pupils were given some warm up exercises whilst the teachers went off to another room for a more detailed teachers' briefing.

At this briefing it was apparent that whilst for some teachers this was their first experience of a Team Challenge, others had been to several previous years' events, and were pleased to come back again. Teachers were invited to give feedback to the UKMT as to the success of the event via an exit evaluation questionnaire, and also, if they wished, to help organise the challenge for subsequent years. The host school provided lunch for the teachers and their teams before the heat got formally underway.

In the first round the students had 40 minutes in which to answer 10 questions of a quite disparate problem solving nature. No A level Mathematics curriculum work was involved. The evaluator observed all the participating students working diligently on task, discussing the problems with each other. The second round was the 'cross number' in which students in the teams worked in pairs, one pair doing the across clues and the other the down clues. Both pairs had sight of the answer sheet and they could ask if a digit was correct, being penalised if it was not but then being told what it should be. Again the students were engaged in the task, although several teams did finish easily within the time available. The third round was the "relay" which sounded quite complex in its organisation but students seemed to understand very quickly how it would work. One pair from a team would do odd number questions and the other pair the even numbered questions, with the "relay" aspect coming in through each subsequent question requiring the answer from the previous question to solve it. Doing this challenge against the clock was a demanding ordeal for the students, with each pair dependent on the

other to answer the next question, but again they all seemed positively engaged with what they were doing and on task.

In between rounds, whilst teachers were doing the marking, the evaluator was able to talk to some of students and teachers taking part. One team of students, who had travelled some 30 miles with their teacher to be present, explained that they just enjoyed taking part. They did not expect to win. The teacher explained that given their school's rural position they are quite prepared to travel to a variety of FMSP events, and the students and accompanying staff enjoy a break from the usual school day, and find taking part in the 'challenge' stimulating. This view was reiterated by many other teachers present, although a couple did seem to feel they had been imposed on to bring their team to the event. Others though said they appreciated the opportunity to meet teachers from other schools, as well as gaining ideas for resources that they could take back to school to share and develop with their colleagues. Several noted the problems were different to those students normally encountered in their A level studies and were stimulating for that. One teacher commented that she got a 'buzz' from just being with about 100 students all of whom were enthusiastic for the mathematics challenges put to them; she said it was very refreshing. All the students who the evaluator spoke too said that the tasks were demanding but they enjoyed the challenge. Some had done some preparatory work using past challenge questions, whereas others had just turned up to see what they could do.

It was interesting at the end for, although there was a presentation of certificates to the third and second placed team and the winning team (certificates presented by the evaluator!), the students were not given any feedback of whether their work was right or wrong. This seemed very fair in that no team went away feeling that they had done badly; however the position of each team was made known to the teacher in charge if he/she wished to know it.

In discussion with the local FMSP AC at the end of the event, he noted that some schools take the 'challenge' very seriously and do lots of preparation whereas others just let their students have a go. He noted that some schools would like to enter two teams. He thought this was good as it encouraged schools to have their own mini competitions from which they could select their 'best team'. He noted the fun element of the challenge was important else it is too much like an examination. He also noted the importance for the students of an event like this in representing their school in an out of school event. It also gave them a chance to meet students from other schools. The fun element was mentioned by many of the students at the end of the event, several saying you cannot really prepare for the questions as they are so variable in nature but they are challenging and make you think. Some teachers and the pupils thought it good to have a mix of Year 12 and 13 as the Year 13 students had some experience of what to expect in the event. Some students had taken part in the Junior Team Challenge, when younger.

In conclusion the evaluator felt that was a stimulating and enjoyable day for both the students and their accompanying teachers. The teachers had resources to take away with them and in general the students had relished the challenge and, through that, benefited from the experience.

6.6.1 Feedback from Heats across the UK

At the end of this event the UKMT organiser reminded the teachers to leave the evaluation feedback form. These forms are collected at the end of each heat across the country and give the UKMT feedback as to the quality of the event in terms of its organisation; the venue and catering arrangements; the 'challenge' itself; and the appropriateness of the problems put to the teams. A sample of these feedback forms from heats around the UK was made available to the evaluator. On a scale of 1 to 4 where 1 was poor and 4 was excellent, the responses on venue, refreshments and organisation of the day were mostly 4s with some 3's with the occasional 2 referring to the quality of the refreshments provided. There were some comments about the venues as being too hot, too cold or too small but in general most teachers were very satisfied with the organisation of the event in their area. Most teachers too thought the level of the mathematics required and the problems set were just about right. Several thought that the cross number this year was easier than in previous years, but others thought some of the other problems were very difficult although there was some variation in opinion. Most thought the difficulty level about right, suitably challenging and discriminating so that there would be a winning team. All the feedback forms examined had responded 'yes' to would they recommend the event to others. Suggestions for improvement were mostly of a practical nature, such as provide better parking information or a warmer hall or ensuring the microphone works. One commented that some schools were entering 'out of district' and suggested they were aiming for tactical advantage. Some teachers wanted to enter two teams. Most teachers though were very happy with the event, and made a complimentary remark at the end of their form, usually involving the word 'excellent' or as one teacher put it 'we've had an extremely enjoyable and worthwhile afternoon; thanks very much'. That very much sums up the general feeling of the teachers about the STMC Challenge.

7. Student Feedback

7.1 Student survey: results and analysis

After the end of the courses in A level and AS level Further Mathematics in the summer of 2010, students who had received their tuition through the FMSP were invited to take part in an online survey of their experience of the FMSP. There were 150 responses to the survey.

Table 10 shows how these 150 students received their tuition. Table 10 shows how they rated both the standard of the tuition itself and also the standard of the online resources made available to them by the FMSP to support their study.

Table 10 How FMSP students received tuition

	Number of students	Percentage
Face-to-face lessons	102	68
Regular online sessions	25	17
Both	23	15

source FMSP

Table 11 Student ratings of the tuition and the resources provided to support their study

	Tuition		Resources	
	Number	Percentage	Number	Percentage
Excellent	86	58	68	45
Good	50	34	57	38
Satisfactory	10	7	11	7
Poor	3	2	0	0
Did not use	-	-	14	9

source FMSP

It is seen in Table 10 that the vast majority of students had their tuition provided by a FMSP tutor in face-to-face lessons. It is also seen in Table 11 that over 90% of the students rated their tuition as either excellent or good which speaks for the quality of the tutors provided by the FMSP both for the face-to-face lessons and the online support. Similarly over 80% of the students thought the online resources provided were at least good, with relatively few saying they made no use of them.

The students were asked about their higher education intentions, with 148 indicating they intended to go to university and 48 saying they intended to read mathematics. Of the remainder, only 12 indicated their intention to study in a non-STEM related area, with many indicating they would continue to study mathematics together with a science or type of engineering. These opportunities are unlikely to have been available to these students without the support of the FMSP, which may have influenced their decisions and helped them achieve the A level grades needed for entry.

The students were invited to make any comment they wished about the tuition they had received and 85 did so, with about half of these saying something very positive about it. The main criticism was that they would have liked more time for face-to-face contact and online support.

7.2 Interviews with students

As part of the student survey, outlined in 7.1 above, students were asked if they would be willing to take part in a follow up telephone interview and 25 of the respondents indicated a willingness to do so. The evaluator attempted to contact 20 of these students using the email address they had supplied, but there were only five positive responses.

However, these five students were interviewed, and the evaluator followed a pro-forma covering the following questions:

- (a) When and why did you decide to study Further Mathematics?
- (b) Where and how did you study Further Mathematics?
- (c) What did you find good about studying through the FMSP?
- (d) What could have been better?
- (e) Where and what are you studying now?
- (f) What has studying Further Mathematics done for you?

7.2.1 When and why did you decide to study Further Mathematics?

Two students decided during Year 12 that they wished to study for a degree in Mathematics so taking Further Mathematics would be beneficial to them. Another student also thought that taking some extra mathematics would be helpful to him. He studied the AS level in Year 13 having given it up in Year 12 because too much travel was involved. Another student realised during his GCSE years that he liked mathematics and he just wanted to do more. One student had been influenced by the experience of her older brother, who was one of the first to take Further Mathematics at their school.

7.2.2 Where and how did you study Further Mathematics?

There was a mix of responses to this question. One student described how he and his three colleagues taking the course made use of the online lessons and support resources, but also had support days at the local university. Another student described how a tutor came to his school to give lessons to about 20 students from the local schools in the area. They too had support sessions at the local university. One student explained that due to his personal circumstances he did all his studying at home, making use of online lessons and support resources, with tutor support through email and telephone and text books that were provided. He noted this was not an ideal situation, but it worked out satisfactorily for him. Another student said he and his originally six colleagues travelled regularly to the local university for lessons from a tutor. He noted that three of his colleagues dropped out; he thought due to time demands. He said there was a lot of pressure time wise, but that he coped although he did a lot of work outside of the university sessions also making use of the online resources. Another student also travelled regularly to her local university for a lesson from a tutor. This was supplemented with text book work and online support. She explained that Further Mathematics was taught at her school but it would not fit her time table, so she took up the FMSP provision with her school's support.

7.2.3 What did you find good about studying through the FMSP?

One student noted that just being able to study Further Mathematics was really good for him; he could really get into the mathematics. He had had some connectivity problems regarding online support, but overall he described the teachers as 'great', and he liked the way the support was flexible. Another student also described the online lessons as being really good, and he noted the online revision lessons had been really helpful as well. The student who worked at home due to his personal problems described the support he got from the AC as "fantastic", and he too thought that the resources were really good. Another student said just the experience of going to the local university and being taught in a lecture room, was good preparation for higher education. He thought too that studying Further Mathematics had helped him with his main A level course in Mathematics. One student thought the pace of the lessons was good, and a lot faster than she had experienced at school; this suited her well. She noted the support available as good, and that any problems she had were soon resolved.

7.2.4 What could have better?

One student just said it had been really good; he had had no problems and could work flexibly within the way the tutoring was offered. Another student described the textbooks as 'awful', and did not think they were of much use in

self-study and said this was a general feeling amongst the other students. Apart from that he felt that the self-study through the online support had been good and he had benefited from not being taught and having to find things out for himself. Another student had hoped for some revision sessions at his local university, but noted there was little time for these, but he had made use of some online sessions. Another student noted that she would have liked more opportunity for revision, but noted it was not a big problem for her. She noted she spent some 45 minutes travelling, and perhaps the time could have been better spent.

7.2.5 *Where, and what are you studying now?*

Two of these students were now studying Mathematics at university and noted that they were finding the work of the first year there relatively easy; studying Further Mathematics had given them a good start. Another student who is studying Chemistry, noted that some of the extra mathematics he had studied was useful, but more so that the overall experience of studying through the FMSP was good preparation for university. He had hoped that taking Further Mathematics would have helped rather more with his main A level in Mathematics but thought it had not done much in that respect. Two of these students were still at school in Year 13. One had decided she wanted to do a Mathematics degree whilst the other had decided against it, and was applying for a Biological Science courses.

7.2.6 *What has studying Further Mathematics done for you?*

The two students now studying for Mathematics degrees not only noted the head start studying Further Mathematics had given them, they had also had the confidence to apply to a 'more prestigious university' as one of them put it. One student did query whether taking Further Mathematics really did help if you were not going to do a degree in Mathematics, but he did appreciate the study skills he had developed. The Year 13 student who wanted to do a Mathematics degree was very pleased she was able to study Further Mathematics and hoped it would help her to be offered a place at the university of her choice. She noted that doing Further Mathematics had really enhanced her interest in the subject, and she now felt the main A level was rather boring. The Year 13 student who had decided not to study Mathematics at university, noted that had there been more tuition time he might well have done so. However, he was very glad he had done the AS course as he felt it "looked good" on his UCAS form and overall it had been a good experience. He would recommend studying Further Mathematics through the FMSP to other students, but noted the need to "stick at it".

7.3 Feedback from Student Events

The FMSP puts on a range of events across the country, specifically aimed at students, and organised by the local AC. There are revision events for students preparing for examinations in both AS level and A level Mathematics and Further Mathematics, enrichment events for students in Key Stages 4 and 5, and also careers related events on the theme of 'Why take mathematics post-16?'. The events are promoted on the regional pages of the FMSP website and brought to local teachers' attention by the ACs through emails.

Feedback is collected by the organisers of these events using standard exit evaluation forms provided by the FMSP Office.

This feedback is summarised by the organising AC or FMSP Central Team and a copy of the summary and feedback forms is sent to the FMSP Central Team for the central records. The feedback in the first instance is of use to the organiser of the event in informing the organisation of subsequent events. The feedback form asks students to rate aspects of the event on a scale of 1 to 4, where 1 is poor and 4 is excellent. These aspects generally encompass the content of the day as a whole, the quality of delivery, the materials provided, the suitability of the venue and the refreshments and lunch provided. Other questions are customised to particular types of event, and space is provided for feedback comment from the participating students.

The evaluator looked at a sample of the summaries of feedback forms on student revision events. It is noted that aggregation of these would be useful to obtain a national picture of provision and the student response to it, so that the FMSP Central Team could have an overview and also the potential for further analysis by type of course or region. This is something that the Central Team may wish to consider. The number of students attending varied considerably ranging in this sample from 6 to 33, but the number attending is bound to vary with the module(s) being revised. In looking at a selection of these summaries from 12 events, it was notable that in the standard five categories the average scores were generally well above three, with the lowest category being refreshments and lunch. There was variation between individual students, but generally there was a high degree of satisfaction with the day as a whole, the quality of delivery and the materials provided. In other questions students said overwhelmingly that they felt better prepared for their examination following the day, the number of questions worked on was about right and they would recommend the event to others. The evaluation form also asked students to comment if they felt some areas of the module had not been covered and any ideas for improvement. These were particular to the various modules and provide valuable information for the event organisers.

A few teachers also attended some of these events and they too completed an exit evaluation exit form, which again were summarised. Teachers tended to give higher scores than the students, particularly in the first three categories.

8. Stakeholder views of FMSP

The views have been sought of a range of prominent stakeholders within the mathematics and wider STEM communities on the activities of the FMSP. The responses received are listed below in alphabetical order, with no editing of the response made.

Dr David Acheson – President
and Professor Adam McBride – Chair of Council
The Mathematical Association

The FMSP (and the FMN before it) have been a major factor in the increased uptake of GCE Further Mathematics in England. The key role of the FMSP is evidenced by the lack of similar growth in Northern Ireland and Wales.

The availability of provision to support schools and colleges which did not previously offer GCE Further Mathematics has ensured that many learners in those centres have had access to GCE Further Mathematics and that higher education has felt more able to state a wish for it in entry requirements. This increased access, together with advocacy to higher education on behalf of GCE Further Mathematics, has led to a major change in attitudes to GCE Further Mathematics leading to increased uptake across nearly all centres, not just those supported by the FMSP.

Nevertheless, penetration is not complete with still about a third of post-16 centres not offering GCE Further Mathematics. Often this is driven by financial considerations (which are only likely to weigh more heavily over the next few years) and any future settlement will need to be structured in such a way as to ensure centres have adequate incentives to provide GCE Further Mathematics and these are not offset by the marginal costs of provision (and savings from its avoidance).

Many centres have seen that involvement with this FMSP has not only given opportunity for their learners to study GCE Further Mathematics but it has also raised the profile of and improved attitudes to mathematics more generally within the centre. Nevertheless, there are still many centres which are not yet strong enough to stand on their own two feet and for which continuing support from the FMSP is still vital.

Many of the learners who are taking and have taken GCE Further Mathematics will be key players in ensuring this country's international competitiveness and we are confident that the modest sums invested in the FMSP (and its predecessor) will provide handsome returns for the country. Looking to the future, which looks ever more mathematical, we need to continue to ensure the supply of mathematically highly educated young people and the FMSP, which has proven a very effective means to that end, would seem very well placed to assist in that goal.

Professor John D Barrow FRS
Professor of Mathematical Sciences
Director, Millennium Mathematics Project
Cambridge University

The Further Maths Support programme has been an outstandingly successful and cost effective programme. With a minimum of administrative overhead it has produced a big increase in the number of students studying Further Maths at AS and A level. This has improved their performance in other maths A levels and prepared them to enter university courses in maths, physics, engineering and other sciences with enhanced confidence in their problem solving abilities and their knowledge of mathematics. It prepares science students as well as mathematicians for the next step in their careers. It has also encouraged schools to make their own teaching provision for the subject and we have seen successful schools become new centres of teaching provision for others in their region. The Programme has pioneered new distance learning methods. I hope the Programme will not only continue but be enlarged and extended in range and scope. It provides university-bound students with the extra mathematical knowledge and expertise that their future lecturers and tutors want them to possess. It is a very wise investment.

Professor Christopher Budd
Professor of Applied Mathematics (and first year lecturer)
University of Bath

One of the biggest problems faced by university maths departments is dealing with the transition between school and university level mathematics. The Further Maths Support Programme has made a huge difference to this. As a result of their good work we can now expect far more students from all school backgrounds to have done further maths than before which means that they are much better prepared for our courses. Furthermore, the online resources that the FMSP has provided have proved invaluable in not only bringing up to speed those students who have not done further maths, but in acting as revision material for those that have. This makes our job much easier, and means that the students can get more out of their university degree. I can also say that the FMSP has given us a much greater opportunity to interact with schools both through the various outreach events that they organise and also in their willingness to act as a link between school students and undergraduates. Long may the FMSP continue to grow and thrive.

Professor Peter J Giblin
Department of Mathematical Sciences
The University of Liverpool

The Further Maths Centre in Liverpool started in 2006. We were exceptionally lucky in being able to recruit a young and enthusiastic

teacher to be the Manager, someone who was highly qualified but simply looking for a part-time post. He has stayed with us since then, now being one of two North-West coordinators of the FSMP. He has brought FM students to the University as well as, of course, organizing groups in other locations. This has brought a new kind of expertise into the Mathematical Sciences Department, attracted excellent students to take mathematically related degree courses, including many in Liverpool University itself, and raised the profile of FM and of the University in the region. Revision classes not only in FM but in core A level, and, recently, a Continuing Professional Development programme in the teaching of FM, aimed at local teachers, have all been developed and expanded during the past few years. Thus the FMSP is truly fulfilling its mission of increasing participation in FM, of giving teachers the skills to take it on themselves, and, as a by-product, of raising the profile of the University among schools in the North-West.

Professor Matthew Harrison
Director, Education
The Royal Academy of Engineering

Engineering is under-pinned by mathematics. For many branches of engineering (electrical and electronic, vibration and dynamics, aerodynamics, systems and control for example) the mathematical topics and concepts required are found in Further Mathematics at A Level and not in the more general Mathematics A Level. The success of the FMSP in increasing participation in these topics is of significant value to the engineering profession because it is helping prepare more young people for their engineering training. This is augmented by the recent support offered by the FMSP to those teaching the Advanced Diploma in Engineering.

One unique feature of the FMSP is that its impact is readily evaluated. Further Maths was in terminal decline until the FMSP (and its predecessor FMN) arrived. It remains in decline in the territories where the FMSP doesn't work. But in England it is growing strongly. The FMSP is the engine for that growth and the engineering profession is an important beneficiary of that success.

Julia Hawkins
Millennium Mathematics Project
University of Cambridge

The FMSP offers an immensely valuable service in a very cost effective way. An equal access to Further Mathematics A level is essential if students aren't to be disadvantaged in applying to the most competitive research-intensive universities. The FMSP is also a very flexible and responsive model, and it is extremely helpful for students to be able to study a Further Mathematics module to enhance their mathematical understanding prior to starting a degree course in, say, Engineering.

Dr Stephen Hibberd
Associate Professor
School of Mathematical Sciences
University of Nottingham

FMSP within the East Midlands is helping to maintain the momentum of increasing awareness of the benefits for advanced study in GCE mathematics, particularly relevant to the study of many STEM subjects at HE. Initiatives to promote and enable the study of Further Mathematics modules to teachers and students in schools and colleges are managed and enabled through an effective expert network. Local activities engage and enthuse students that mathematics is a living and evolving subject, each day being applied to the description and understanding of the physical, biological, commercial, digital and social world around us.

Professor Tom Korner
Chairman of the Faculty Board of Mathematics in Cambridge University

The Mathematics Faculty of Cambridge University strongly supports the activity of the FSMP. Students with only single mathematics A level are doubly disadvantaged when considering studying mathematics or highly mathematical subjects at leading universities. Firstly they lack the knowledge base and manipulative experience which their better prepared contemporaries (both in the UK and abroad) possess. Secondly, and perhaps as importantly, they have little idea of what higher level mathematics looks like and may decide 'because mathematics is boring and easy' not to try for courses which they would enjoy or to 'because mathematics is just rote learning and I will have plenty of time for other things' to try for course that will not suit them.

The Faculty of Mathematics feels that a school which does not offer Further Mathematics is like a school which withdraws Dickens from its library on the grounds that long novels only appeal to a minority.

We think that the best way of judging the success of the program is the number of schools that set up Further Mathematics schemes of their own. By this criterion the program has been very successful in the region that we know best. We strongly support the program.

Professor Jeremy Levesley
Chairman
Heads of Departments of Mathematical Sciences

HoDoMS is very supportive of FMSP in its excellent work in allowing access for a wide range of students to study further mathematics. We think that extension work for students is important in keeping brighter students stimulated and interested in mathematics beyond the standard A level. We are also keen to ensure that good performance in the single A level be viewed as an adequate entry requirement for good universities

and in that regard view the activity of FMSP as providing very valuable extension but not core mathematics education.

Professor Peter Main
Director, Education and Science
Institute of Physics

It is rare in education to be able to pin a change in behaviour to a particular initiative or intervention. However, there is no doubt that the FMSP, and its predecessor, has been largely instrumental in the dramatic and very welcome growth in the numbers of students taking AS and A levels in Further Mathematics. This growth has been a wholly positive feature of the STEM environment. Although Further Maths is unlikely to become an entrance requirement for HE courses in physics and engineering in the foreseeable future, it is undoubtedly an excellent qualification for entrants to such courses, both in terms of knowledge and, particularly, the extra facility in mathematical manipulations. The Programme is to be congratulated on making such a large and positive contribution to STEM education.

Mr Tony Mann
Mathematical Sciences Department
University of Greenwich

The work of the Further Maths Support Programme has been valuable in encouraging more students to take Further Mathematics A level, giving them important mathematics skills and enhanced career and higher education prospects.

Dr Carol Robinson
Director Mathematics Education Centre
Loughborough University

The FMSP in the East Midlands is organised jointly between Nottingham and Loughborough Universities. The two area coordinators are outstanding in their roles and the services they offer across the region reflect their commitment, hard work and dedication.

The FMSP has had a tremendous impact across the region. The enhancement events motivate young people to take an interest in Mathematics and to encourage them to study the subject at A level and beyond. These include Maths at Work conferences, I am an engineer-this is what I do events, Packaging challenges, etc.

CPD for teachers features strongly in the Area Coordinators' work and they are currently preparing CPD events to support teachers in the teaching of Further Mathematics.

Of course overriding all the above is the provision and support for Further Mathematics A level. Local schools have benefited greatly from the provision of twilight classes at Loughborough University. Some of these schools have now taken the teaching of Further Mathematics in house.

Senior managers at Loughborough University are very supportive of the outreach work which is undertaken by our area coordinator as part of the FMSP.

Jon Prichard
Chief Executive Officer
The Engineering Council

The Engineering Council was involved with the original MEI Further Maths Project and we believe that the Further Maths Support Programme (FMSP) has been very successful in building upon this. The success that it has had in reaching and supporting individual schools is indicated by the growth in entries for Further Mathematics at AS and A2 level, which have trebled and doubled respectively within the past five years. Its engagement with and support for teachers and students has been very effective and have tended to lead to improvements in all-round provision and performance in mathematics. This helps mathematics to be recognised and valued by students, which can only be beneficial for a subject such as engineering in which mathematics plays so important a part. The potential of A level Further Mathematics has accordingly come to be recognised by admissions tutors.

Professor Colin Sparrow
Head of Department, Mathematics,
University of Warwick

It is a privilege to work with the Further Maths Support Programme. The programme is extremely effective in raising the profile of mathematics in schools and colleges, and in enthusing, encouraging and supporting students who wish to take Further Mathematics (and beyond).

Feedback informs us that all the activities organised through the Further Mathematics Support Programme are very well received by both students and schools. This includes the support classes and revision days, the CPD training offered to teachers, the on-line resources, innovative ways of teaching, and the enrichment and other events.

Many UK HEIs provide very strong Mathematics degree programmes that either require or recommend Further Mathematics as a prerequisite. The department in Warwick prides itself on delivering a high quality education to its student body, regardless of the background of individual students. The work of the Programme is essential to ensure that we maintain this quality, and that we can attract suitably

qualified students from all schools and colleges, including those who may not themselves be able to provide all the mathematical support required.

Professor Nigel Steele
Emeritus Professor of Mathematics
Coventry University &
Hon Sec IMA

The Institute notes with great pleasure the increased number of students studying both A level Mathematics and also Further Mathematics at AS and A2 levels and believes this to be in the best interests of both students and in meeting the national need. This increase would not be possible without the assistance of some sort of high quality additional support for hard-pressed teachers and their pupils of the type provided by the FMSP. We are strongly supportive of their work.

Professor Charles Taylor
Department of Statistics
University of Leeds

It has clearly made a difference to the number of pupils studying Further Maths at AS and A level. This is clear by considering the take-up of Further Maths in England, Wales and N Ireland. The number of schools offering further maths has increased steadily over the last five years, which is consistent with the aims of the programme, which seeks to support both teachers and pupils across the country.

9. Conclusions and Recommendations

The FMSP is making considerable progress towards achieving its aims of increasing the number of students who study both AS level and A level Mathematics and Further Mathematics, and developing the knowledge, expertise and confidence of teachers to enable them to teach Further Mathematics in their own school or college.

The evidence gathered together in this evaluation report from questionnaire based surveys, interviews and feedback forms is generally very positive. There is no evidence of any strong criticism of the FMSP. Students are generally grateful for the opportunity the FMSP gave them to study Further Mathematics, and teachers are generally grateful for the various aspects of support that the FMSP has offered them, and they want that support to continue. There are some individual criticisms based on their own experience from some students who received tuition through the FMSP and from some teachers who received professional development through the FMSP, but these were relatively few and minor in nature. Nevertheless, it is hoped the tutors concerned have taken note and acted on such criticism.

There is wide spread awareness across England of the FMSP and the services it offers to teachers and students. This is particularly the case for teachers of Mathematics but less so for teachers involved with the level 3 Diploma in Engineering, especially in colleges.

The services that the FMSP offers are taken up to various degrees depending on particular schools and colleges circumstances, but these services are generally valued by those who use them, and by those who have used them in the past. The achievements of the FMSP are generally recognised as positive and productive by mathematics teachers, stakeholders in mathematics and STEM education in general.

Teachers clearly value the professional development opportunities that the FMSP offers, enabling them to learn or refresh their knowledge of topics within Further Mathematics, whilst sharing and discussing ideas with colleagues from other establishments on how best to introduce and teach such topics. For those unable or unwilling to attend face-to-face day events, the online provision is seen as a valued alternative.

Teachers and students are very positive about the resources made available to them through being registered with the FMSP, both in terms of topic-based materials and also help and advice with teaching and learning those topics. Students who received their tuition through the FMSP are generally very satisfied with the experience and grateful for the opportunities that it offered them. It is notable that the large majority of the students surveyed intended to enter higher education either to read for a degree in mathematics or in a STEM-related area.

In the schools and colleges where they are making progress towards taking the teaching of Further Mathematics back in house or are offering it through a consortium arrangement, there are generally enthusiastic and committed teachers, who both want to teach at least some of the modules themselves, but more so want the opportunity to study Further Mathematics to be available to their students. There are many and various timetabling arrangements in place and Further Mathematics may or may not appear in sixth form curriculum option blocks. In many establishments the demand from students currently in Key Stage 4 is considered likely to be high, but there may be difficulties in retaining students post-16 if Further Mathematics cannot be offered in school or college at a time to suit the students.

The long term sustainability of establishments taking the teaching of Further Mathematics back in house or offering it through a consortium arrangement is fragile. It is very dependent on viable student numbers coming forward and confirming their intentions so that senior management at an establishment can guarantee it will be offered and / or it will run.

The stakeholders who responded to the invitation to express a view on the FMSP are also very positive about the achievements and activities of the FMSP. The stakeholders from higher education in particular have emphasised how it is helping to prepare students for the high mathematical demands, not just of a degree in mathematics, but also in STEM-related areas.

The FMSP continues to build upon its previous achievements and the number of students taking Further Mathematics and Mathematics at AS level and A level has continued to increase in England. It is problematical to say that this increase is due solely to the activities of the FMSP, but the comparison with the change in student numbers in Wales and Northern Ireland over the last six years is strong evidence that the influence of firstly the Further Mathematics Network and more recently the FMSP has had a substantial impact.

It seems very unlikely that the substantial growth in student numbers studying Further Mathematics in England would have occurred without the intervention of the FMN and the FMSP. More so, it seems unlikely that the substantial growth in numbers and the associated opportunities for professional development of teachers and support for students will be sustained if the activities of the FMSP were to be curtailed.

The following Recommendations are put forward as a result of this evaluation

1. The FMSP should continue to be funded so that it can continue to support both students and teachers of Mathematics and Further Mathematics.
2. If the FMSP is to continue to support the mathematics of the level 3 Diploma in Engineering, then information about its services needs to reach the teachers who actually deliver the course, particularly in colleges. There is also a need to review the compulsory mathematics within the Diploma in terms of volume of content, accessibility to students and its relevance to engineering.
3. There needs to be a review geographically and by type of institution as to where and how Further Mathematics is being offered and who is taking it up. This should enable future effort to be targeted at helping schools and colleges move towards provision if they do not currently offer Further Mathematics. It should also help to identify how AS Further Mathematics is offered to students, whether this be as a one year course offered in Year 12 and / or Year 13, or as a two year course or not offered at all. It may also help to redress the gender balance between male and female students who choose to study Further Mathematics. In such a review, the FMSP should have access to reliable data on student take up of AS level and A level Further Mathematics. This could involve access to school and college census data, and reconciling this with achievement data from the Department for Education, and also information from the school or college itself, if registered with the FMSP. Local Area Coordinators could also seek this type of information from the establishments in their area.
4. For professional development and other events, it is recommended that the FMSP ensures that standard feedback forms are used and that they are summarised in a standard way that facilitates aggregation. Such aggregated information could be analysed so that a national picture of provision and take up can be established to inform and focus future planning and provision on

need. A survey of teachers' perceived requirements both in terms of content and style of delivery would also inform future planning. The FMSP should continue its development of Knowledge Networks and consider supplementing these with online forums for both teachers and pupils. The FMSP should also continue its support and involvement with the Senior Team Maths Challenge.

5. The FMSP should consider the implications of the revised GCSE in mathematics on take up in both AS level Mathematics and Further Mathematics. The FMSP should offer guidance to teachers and students as to whether there is a minimum grade or pre-16 experience of mathematics that should be a pre-requisite to studying Mathematics or Further Mathematics. The FMSP should consider the provision of bridging resources and / or courses should these prove to be necessary. It should also encourage those students who doubt their ability or who feel they might lack the self-discipline to make a success of supported self-study, that they can succeed in Further Mathematics, especially through taking an AS level over two years, or in Year 13.

6. The FMSP should seek ways to continue to raise the profile of mathematics in Key Stages 3 and 4. The FMSP could develop further guidance in terms of ideas for 'extra-curricular' activities and resources that promote an interest in mathematics as a fun, fascinating and challenging subject to pursue further, and that it leads to many career opportunities.

Limitation of this Evaluation

It is recognised that a great deal of the evidence put forward in this evaluation report has come from teachers and students and stakeholders who were willing to cooperate with interviews and surveys. The approximate return from the two surveys of 25% from one thousand schools was a good return, but it underlines that little is known about any Further Mathematics provision or lack of it in the other 75%. It could be argued that those willing to return a survey questionnaire and more so those offering to be interviewed would be positive advocates for the FMSP and what it has to offer. It remains a challenge for the FMSP to reach the teachers and their students that this evaluation has not been able to do.

10.1 Appendix 1

Questionnaire Survey on the Further Mathematics Support Programme

In August 2009 the former Further Mathematics Network was replaced by the Further Mathematics Support Programme. This questionnaire is about awareness of the FMSP and what it has to offer in terms of supporting the teaching of Further Mathematics and level 3 Mathematics within diplomas. Please circle yes or no to the following questions.

Q1. Are you aware of the existence of the FMSP? yes / no

Q2. Does your Department offer Further Mathematics:

at AS level? yes / no ; at A2 level? yes / no

Q3. Does your school / college offer the level 3 Engineering Diploma?..... yes / no

Q4. Is your Department registered with the FMSP? yes / no

Q5. Which of the FMSP services are you currently using or would you consider using?

Please circle all that apply, or tick 'none' :-

none

tuition in Further Mathematics	use / would consider
advice on delivering Further Mathematics	use / would consider
advice on delivering Mathematics within the level 3 Engineering Diploma	use / would consider
professional development for teachers in Further Mathematics	use / would consider
professional development for teachers in level 3 Mathematics for a diploma	use / would consider
revision events for A level Mathematics	use / would consider
revision events for Further Mathematics.....	use / would consider
enrichment events in mathematics for any Year Group	use / would consider

Q6. Does your Department work in a consortium arrangement with other local schools and / or colleges to offer Mathematics at Key Stage 5? yes / no

As part of the evaluation we are planning to conduct some interviews by telephone with the teacher responsible for AS / A level Mathematics, to explore their views in more depth on the FMSP and the services it offers. The interview would last about 10 to 15 minutes and can be arranged for a date and time that suits you. We are interested in your views, even if your department does not currently make use of the FMSP.

Q7. Are you willing to take part in a telephone interview? yes / no

If yes, please give your contact details name

school / college telephone number

e mail address preferred day / time

Many thanks for your cooperation.

Please return the questionnaire in the prepaid envelope provided.

10.2 Appendix 2

Questionnaire Survey on the Level 3 (advanced) Diploma in Engineering

The Further Mathematics Support Programme(FMSP) has as part of its remit with the Department for Education, the support of the mathematics aspects of the Level 3 (advanced) Diploma in Engineering.

Please answer the following questions.

Q1. Are you aware of the existence of the FMSP?..... yes / no

Q2. Is your school / college registered with the FMSP?..... yes / no

Q3. Is your school / college offering the level 3 Diploma in Engineering in 2010/11?..... yes / no

If yes, how many students do you currently have following the course?

Q4. Does your school / college plan to offer the level 3 Diploma in Engineering in 2011/12?..... yes / no

Q5. has your school / college previously offered the level 3 Diploma in Engineering?..... yes / no

Q6. The FMSP offers a range of services to schools and colleges to support teachers in delivering the mathematics aspects of the level 3 Diploma in Engineering.

Which of the FMSP services are you currently using or would you consider using?

Please circle all that apply, or tick 'none' :-

none

advice on delivering Mathematics within the level 3 Diploma in Engineering use / would consider

professional development for teachers in level 3 mathematics for the Diploma use / would consider

enrichment events for mathematics for any Year Group use / would consider

Q7. Does your school / college work as part of a local consortium arrangement to deliver the level 3 Diploma in Engineering? yes / no

If yes how many (a) schools, and (b) colleges are in the consortium? Schools

Colleges.....

As part of the evaluation we are planning to conduct some interviews by telephone with the teacher / lecturer in charge of the course to explore in greater depth their views on the mathematics aspects of the Diploma and how the FMSP might better support the delivery of these. The interview would last about 10 minutes and can be arranged for a date and time that suits you. We are interested in your views, even if your school / college does not currently make use of the FMSP.

Q7. Are you willing to take part in a telephone interview? yes / no

If yes, please give your contact details name

school / college telephone number

e mail address preferred day / time

Many thanks for your cooperation.

Please return the questionnaire in the prepaid envelope provided.

10.3 Appendix 3

Professional Development Evaluation form for delegates

We value your feedback and would be very grateful if you would let us have your views about this event. Please complete the form below and hand it in at the end of the day.

Event:		Date:	
Your school/College (optional)		Venue:	

Aims of the day	
------------------------	--

Please rate the following aspects of the course using a scale of 1 to 4, where:

1 = Poor; 2 = Adequate; 3 = Good; 4 = Excellent.

	1	2	3	4	Comments
The information you received in advance of the course.					
The organisation during the course.					
The course content					
The standard of delivery of the training					
The suitability of the training venue/equipment.					
Refreshments at the course venue.					
What were the most useful aspects of the day?					
What changes (if any) would you suggest we make when planning future events?					
Are there any other comments that you would like to make?					

The FMSP is hoping to assess the longer term impact of teacher CPD. Are you willing to be contacted in future to follow up on your feedback? Yes No

If you said yes, please provide your name, e-mail address and/or telephone number

If you would prefer us not to pass your contact details to the NCETM regional coordinator, please complete the following boxes

I do not want the NCETM to contact me with information on mathematics education

Thank you for taking the time to complete this form.

10.4 Appendix 4

Student entries and achievement in Further Mathematics and Mathematics in England, 2003/04 to 2009/10.

(source DCSF/DfE)

Table A1 GCE A level Further Mathematics entries

Academic year	All student entries – percentage achieving grade								
	A*	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	29.3	30.1	20.2	11.4	5.4	2.8	99.3	10813	14.5%
2008/09		59.1	20.2	11.0	5.4	3.2	99.0%	9443	11.8%
2007/08		58.2	20.6	11.1	5.7	2.9	98.4%	8447	16.7%
2006/07		57.0	20.1	11.5	6.7	3.4	98.6%	7241	11.1%
2005/06		57.8	19.4	11.7	6.5	3.5	98.9%	6516	25.5%
2004/05		59.0	17.7	11.0	6.8	3.7	98.1%	5192	1.6%
2003/04		59.4	16.8	10.6	6.7	4.3	97.9%	5111	

Table A2 GCE A level Further Mathematics entries; male students

Academic year	Male student entries – percentage achieving grade								
	A*	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	30.0	29.3	20.3	11.1	5.5	3.1	99.2%	7369	13.5%
2008/09		59.4	19.7	10.4	5.8	3.6	98.9%	6493	10.6%
2007/08		58.0	20.1	11.3	5.7	3.1	98.3%	5871	15.1%
2006/07		57.1	19.5	11.7	6.9	3.4	98.7%	5099	10.9%
2005/06		57.5	19.2	11.7	6.9	3.5	98.7%	4596	23.2%
2004/05		58.0	17.7	10.8	7.6	3.8	98.0%	3730	0.8%
2003/04		58.9	16.9	10.9	6.8	4.3	97.7%	3699	

Table A3 GCE A level Further Mathematics entries; female students

Academic year	Female student entries – percentage achieving grade								
	A*	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	27.7	31.9	20.1	12.0	5.3	2.3	99.3%	3444	16.7%
2008/09		58.6	21.3	12.4	4.6	2.3	99.2%	2950	14.5%
2007/08		58.7	21.7	10.4	5.5	2.4	98.7%	2576	20.3%
2006/07		56.5	21.6	10.9	6.1	3.2	98.4%	2142	11.5%
2005/06		58.3	20.1	11.9	5.5	3.6	99.3%	1921	31.4%
2004/05		61.4	17.6	11.4	4.7	3.4	98.5%	1462	3.5%
2003/04		61.0	16.6	10.1	6.4	4.4	98.4%	1412	

Table A4 GCE AS level Further Mathematics entries

Academic year	Student entries - percentage achieving grades							
	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	41.9	19.2	13.8	10.6	6.9	92.5%	9421	12.2%
2008/09	41.0	19.7	15.0	10.3	7.0	93.1%	8399	48.5%
2007/08	37.6	20.2	15.9	10.9	7.4	92.0%	5654	15.1%
2006/07	38.5	19.2	15.7	10.4	7.2	91.0%	4912	20.5%
2005/06	37.9	19.8	16.8	11.2	7.5	93.3%	4078	20.4%
2004/05	39.2	18.6	14.6	12.1	7.6	91.9%	3388	32.6%
2003/04	32.9	19.1	18.0	13.2	8.2	91.4%	2555	

Table A5 GCE AS level Further Mathematics entries; male students

Academic year	Male student entries - percentage achieving grades							
	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	40.3	18.9	13.9	10.9	7.4	91.4%	5911	13.9%
2008/09	39.3	19.1	15.5	10.6	7.8	92.4%	5190	45.5%
2007/08	35.8	20.0	16.2	11.4	7.8	91.1%	3567	15.8%
2006/07	37.3	18.4	16.3	10.7	7.8	90.5%	3079	21.4%
2005/06	35.9	19.3	17.0	12.1	8.1	92.5%	2537	15.7%
2004/05	38.6	17.1	14.7	13.2	7.8	91.3%	2193	31.2%
2003/04	30.7	18.5	18.0	14.4	9.3	90.9%	1671	

Table A6 GCE AS level Further Mathematics entries; female students

Academic year	Female student entries - percentage achieving grades							
	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	44.6	19.7	13.7	10.1	6.2	94.3%	3510	9.4%
2008/09	43.8	20.7	14.1	9.9	5.7	94.2%	3209	53.8%
2007/08	40.7	20.5	15.5	10.1	6.8	93.6%	2087	13.9%
2006/07	40.4	20.5	14.7	10.0	6.3	91.9%	1833	18.9%
2005/06	41.3	20.6	16.5	9.8	6.5	94.7%	1541	29.0%
2004/05	40.3	21.3	14.4	10.0	7.1	93.1%	1195	35.2%
2003/04	37.2	20.2	17.9	11.0	6.0	92.3%	884	

Table A7 GCE A level Mathematics entries

Academic year	All student entries – percentage achieving grade								
	A*	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	17.0	27.9	22.0	15.5	10.1	6.0	98.5%	69803	8.2%
2008/09		45.4	21.7	15.3	10.1	5.8	98.3%	64519	12.0%
2007/08		44.2	22.2	15.4	10.2	6.0	98.0%	57618	8.0%
2006/07		43.8	21.5	15.6	10.7	6.0	97.6%	53331	7.1%
2005/06		43.3	21.2	15.6	10.8	6.7	97.6%	49805	8.2%
2004/05		40.6	21.6	16.0	11.5	7.1	96.8%	46034	0.0%
2003/04		37.8	21.5	16.9	12.1	8.0	96.3%	46017	

Table A8 GCE AS level Mathematics entries

Academic year	Student entries - percentage achieving grades							
	A	B	C	D	E	pass rate	total entry	percentage increase
2009/10	23.5	16.5	15.5	14.2	12.3	81.9%	79458	7.8%
2008/09	23.3	15.3	15.1	14.9	12.9	81.5%	73728	11.4%
2007/08	23.6	15.7	15.4	14.4	12.5	81.6%	66208	5.3%
2006/07	24.3	15.0	14.8	14.2	12.7	80.9%	62896	9.1%
2005/06	25.0	15.3	15.0	13.6	12.2	81.1%	57647	4.9%
2004/05	24.3	14.9	14.4	13.7	12.7	79.9%	54972	7.7%
2003/04	21.0	14.1	14.5	14.4	13.4	77.4%	51037	