Evaluation of the Further Mathematics Support Programme

Report on Phase Four

Dr Jeff Searle
March 2014
Contents

Executive summary ........................................................................................................ page 4

1. Introduction and background .................................................................................. page 8
   1.1 Introduction to this evaluation
   1.2 Background information about the FMSP

2. Area Coordinators and their perception of the role ................................................. page 10
   2.1 Background
   2.2 Interviews with Area Coordinators
   2.3 Conclusions

3. Developments in FMSP Professional Development .............................................. page 14
   3.1 Overview of professional development offered by the FMSP
   3.2 The Live Online Professional Development programme
      3.2.1 Observations of two sessions
      3.2.2 Feedback from teachers who participated in LOPD
      3.2.3 Conclusions
   3.3 Sixth Term Examination Paper / Advance Extension Award
      Professional development for teachers
      3.3.1 Observation of a STEP/AEA professional development event
      3.3.2 Feedback from teachers who attended a STEP/AEA event
      3.3.3 Conclusions
   3.4 Extension and Enrichment for Key Stage 4 students
      Professional development for teachers
      3.4.1 Background and enrichment and enhancement events
      3.4.2 Observation of an Enrichment and Enhancement event
      3.4.3 Feedback from interviews with attendee teachers
      3.4.4 Summary of teacher feedback from event exit evaluation questionnaires
      3.4.5 Extension and Enrichment Conference – February 2014
      3.4.6 Conclusions
4. **Developments in FMSP Tuition** ........................................ page 30

4.1 Overview of FMSP Tuition  
4.2 Live Interactive Lectures for Further Mathematics  
  4.2.1 Observation of two sessions  
  4.2.2 Feedback from teachers  
  4.2.3 Conclusions  

5. **Impact of the Further Mathematics Support Programme** ...... page 34

5.1 Registrations with the FMSP  
5.2 Development of Further Mathematics in schools and colleges  
  5.2.1 Classification of schools and colleges by take up of Further Mathematics  
  5.2.2 Survey of teachers  
  5.2.3 Data analysis of the impact of introducing Further Mathematics to a school or college curriculum  
  5.2.4 Impact of the FMSP from the perspective of the Area Coordinators  
  5.2.5 Development of Further Mathematics in the Priority Schools  
  5.2.6 The FMSP and Teaching Schools and Academy Chains  
  5.2.7 Further Mathematics and admission to university  
5.3 Stakeholders’ views of the FMSP  

6. **Update and feedback on current FMSP services and events** .. page 59

6.1 The Senior Team Mathematics Challenge,  
  The Year 10 Mathematics Competition  
6.2 Statistics and feedback on the take up of professional development  
  6.2.1 Teaching Advanced Mathematics – The TAM course  
  6.2.2 Teaching Further Mathematics – The TFM course  
  6.2.3 Other professional development opportunities  
  6.2.4 FMSP Associates events  
  6.2.5 The Access to Further Mathematics events  
6.3 Student tuition by the FMSP  
  6.3.1 Data on students who received tuition through the FMSP
6.3.2 Feedback from students who received tuition through the FMSP
6.3.3 Data on student revision sessions
6.4 Data on the take up of AS and A level Further Mathematics
   6.4.1 National data
   6.4.2 Change in status of schools and colleges registered with the FMSP
7. Conclusions and recommendations

Appendices
A. Definitions of priority schools/colleges
B. Detailed report following observation of two LOPD online sessions
C. Detailed report following observation of the event, Preparing students for STEP / AEA Mathematics
D. Detailed report on the professional development event Extension and Enrichment at Key Stage 4
E. Detailed report following observations of LIL FM sessions
F. Case studies of establishments that offer Further Mathematics
G. Data analysis of the impact of introducing Further Mathematics;
   Tables 5.3, 5.4, 5.5, 5.6
H. Stakeholders’ views on the FMSP
Executive Summary

The current evaluation is the fourth in a series of evaluations carried out by the Centre for Evaluation and Monitoring at Durham University, commissioned by the Further Mathematics Support Programme (FMSP). Phases 1, 2 and 3 of the evaluation covered the period from the formation of the FMSP in 2009 to the report on Phase 3 in 2012. The Phase 4 evaluation considered a wide spectrum of FMSP activity including the work of the Area Coordinators and developments in teacher professional development and student tuition. The report also includes an analysis of the impact of the FMSP and an update on feedback from FMSP services and events.

FMSP Area Coordinators

Interviews with 15 of the 30 Area Coordinators (ACs), showed that the ACs continue to play a vital role in promoting awareness of the various services the FMSP has to offer in their region, and also in supporting schools and colleges in taking advantage of these services in the development of their provision in mathematics at both Key Stages 4 and 5. The ACs also play a key role in the FMSP’s aim of enthusing both pre- and post-16 students about mathematics and motivating students to want to study the subject at higher levels than their current course. The ACs are clearly highly motivated individuals, who work closely with the similarly highly motivated members of the FMSP Central Team to help develop mathematics education both locally and nationally.

Professional Development for Teachers

Live Online Professional Development (LOPD): Since 2008, the FMSP has been developing and extending its provision of online professional development courses for teachers in A level Mathematics and Further Mathematics using virtual classroom software. The nine interviews conducted in this current evaluation show these courses are working extremely well. This is supported by the feedback in the end of course evaluation forms. Teachers find these courses to be good or excellent in the terms of the content provided, the way in which the content is delivered and the structure of the course in being over several sessions. Teachers value the interaction that can take place during a session, the option to review a session using its recording and having the time to reflect on a session before the next one. This is an area that the FMSP should look to develop and extend further.

Sixth Term Examination Papers / Advanced Extension Award (STEP / AEA): This aspect of professional development for teachers was first introduced by the FMSP in 2012/13. It aims to highlight the problem-solving skills that students will need to develop in order to be successful, and to support teachers in how to develop these skills in students, and not necessarily just those who intend to sit these examination papers. The various events held around the country were very well attended by teachers, indicating the need for this provision. At an observed event, teachers worked enthusiastically at typical problems, relishing having the time both to do so and also to discuss how they might introduce and work with problems like these with their students. The seven interviews conducted with delegates to different events and the exit evaluation forms show that teachers valued these events despite their somewhat demanding nature in terms of the mathematics. The FMSP should clearly offer these events again, and possibly consider increasing their number.

Extension and Enrichment for Key Stage 4 Students: During 2012/13, the FMSP held a series of events through which teachers could acquire resources and ideas with which to deliver extension and enrichment sessions to students in their school. These events were aimed particularly towards students who were studying at Higher Tier GCSE. The event in each venue was held over two days,
separated by several weeks. This enabled delegates on the first day to experience activities themselves and gather resources and teaching strategies which they could share with colleagues and try out with their students at school and on the second day to share their experiences and reflect upon them in discussion with other delegates and the course presenters. The evaluator observed a two day event and judged it to be very successful in meeting its objectives. The feedback from telephone interviews with teachers who had attended some of the events was very positive. They have clearly got a lot out of attending and so have their schools. The teachers were enthusiastic about this aspect of mathematics teaching and learning and want to develop it in their schools. The exit evaluation forms from the events show this positive view of the event to be shared by the vast majority of the delegates.

**Developments in Student Tuition**

**Live Interactive Lectures for Further Mathematics (LIL FM):** LIL FM is a new development by the FMSP in student tuition building on the face-to-face and online tuition provided in previous years, although these two latter services continue to be offered. LIL FM was initially set up to support students who were on a limited timetable for Further Mathematics at their school/college, of typically 2 hours a week, and where student numbers were low, usually below five. The interviews with five teachers from schools where LIL FM is being used showed that although this is the case in some establishments, LIL FM is proving versatile in the way it can be used. In particular where a school/college does offer conventional face-to-face teaching in a full timetable, but due to clashes, a student can’t access the classes; LIL FM provides an alternative. In another case, LIL FM was being used to support ‘distance learning’ by a student who had the school’s agreement to only attend occasionally. The teachers reported that the students are generally happy with the way LIL FM operates and the resources provided through it, and they find the provision to be cost effective. The FMSP should look to develop LIL FM and the various ways in which it might be of use in supporting students in different circumstances.

**Impact of the FMSP**

**Registrations with the FMSP and Student Entries to A level Further Mathematics:**
Most state schools with sixth forms have now registered with the FMSP, as have about half the 11-16 schools indicative of the growing influence of the FMSP in the pre-16 sector. About a third of colleges in England are also registered.

An analysis of student entries to A level Further Mathematics in schools/colleges over the ten year period 2003/12 has shown steady growth, but this doesn’t relate particularly to a type of school or college. Some schools/colleges have a very viable number of students year on year, whereas some have very few and in some years no students. Schools/colleges were categorised by the number of students they have had over the period 2008/12 and a survey conducted with a sample of teachers from each category on their provision for Further Mathematics. This report includes eleven case studies, which illustrate that whereas some schools/colleges are content with their current numbers others are hoping for further development. Teachers showed awareness of possible barriers to such development, not least of which was concern over the impact of possible changes to A level qualifications in general, in the near future.

**Data analysis:** An analysis was conducted using DfE data on the impact of introducing A level Further Mathematics into a school/college on the number of students taking A level Mathematics, and their achievement. This covered the ten year period 2003/12 and indicated that in general the introduction of Further Mathematics increases both the numbers taking A level Mathematics and
their achievement in subsequent years, although there was a lot of variation between individual schools and colleges. Teachers from the survey also indicated a belief that students who take Further Mathematics are likely to improve their achievement in A level Mathematics.

**Area Coordinator Survey:** A survey was conducted amongst the 30 ACs to find their views on the impact of the FMSP. The ACs noted this was a difficult task and there was considerable variation in their responses as to which aspects of the FMSP had had the most impact. However, there was some consensus. In provision for teachers it was thought that advice on delivering Further Mathematics and take up of professional development opportunities had had the greatest impact. In provision for students it was thought that making tuition available to all students had had the greatest impact, and also the provision of enrichment events for Key Stage 4 students. In how the FMSP is structured, the ACs highlighted their role and that of the Associates in being locally based and knowing the needs and circumstances of the schools/colleges in their area, but noting that this was supported by the Central Team. The survey was followed up by interviews with half of the ACs, which emphasised the above points, but also that teachers have come to expect high quality services and events from the FMSP, and that feedback confirms that is what they get. It was felt that teachers value the services and events the FMSP provides and more so having someone available locally that they can turn to for advice and support as the needs arises.

**Priority Schools:** During the interviews, the ACs were asked about progress with priority schools in their area. The picture was similar in all areas in that whereas some schools are now engaging with the FMSP and using its services and attending events, there is no response from some schools. The ACs highlighted how important it is to make a personal contact with a teacher before any development is likely to take place; they noted it can be a slow process from first contact to the actual offer of Further Mathematics to students but once initiated numbers often grow. Interviews were conducted with ten teachers from priority schools that are engaging with the FMSP and all now are offering Further Mathematics to their students with FMSP support, but usually teaching at least some the mathematics themselves. These teachers too were grateful for the support and advice they had received from their AC in initiating their provision of Further Mathematics.

**Teaching Schools:** Some of the ACs put the evaluator in touch with a teacher from a school in their area with Teaching School status; six interviews took place. There is a lot of potential development in the partnerships and alliances that are developing around these schools, and the teachers are keen for the FMSP to be involved. In some cases the AC is already helping with the planning and delivery of professional development, and this is clearly an area that the FMSP should pursue further, including initial teacher training. In contrast, an attempt was made to contact teachers from schools in academy chains, but this proved largely unsuccessful.

**Further Mathematics and Admission to University:** A review was conducted using information from a range of university websites and prospectuses of the entry requirements to mathematics and mathematics related degree courses. Currently Further Mathematics is insisted on for a mathematics degree by 9% of the universities, but not for any other degree courses, although it is generally preferred that students have studied Further Mathematics. Interviews with four admission tutors, illustrated this contrast, in that some universities attract students who will achieve grade A* in both Mathematics and Further Mathematics and admission depends on such achievement, whereas others are more flexible. It was noted that recently more applicants have studied Further Mathematics to at least AS level, and some universities are amending the first year of their course as a result.
Mathematics Stakeholder Views on the Work of the FMSP: A number of stakeholders in mathematics education and related subjects were contacted to solicit their views on the FMSP. The stakeholders included university academics, teachers, local authority employees and representatives of professional associations. The 30 responses received were all overwhelmingly positive about the various services that the FMSP has to offer and what it is achieving in terms of a key role in increasing the number of students studying A level Mathematics and Further Mathematics and the quality of students taking up mathematics and related subjects at university. The stakeholders were agreed that the FMSP has done much to raise the profile of mathematics and especially in encouraging Key Stage 4 students to continue their study of the subject into A level and beyond. They also noted that through the FMSP and the local Area Coordinators there are now stronger and developing local links between schools, universities and local authority support services.

Update on Feedback from FMSP Services and Events

STMC; Year 10 MC: The Senior Team Mathematics Challenge continues to be very popular and there is considerable interest in the recently introduced similar competition for Year 10 students.

TAM; TFM: The two 14 month long professional development courses, Teaching Advanced Mathematics and Teaching Further Mathematics, continue to attract participants. Teachers who have participated in these courses in the last year gave very positive feedback similar to those who had participated in previous years. Teachers benefit through acquiring resources and teaching strategies and developing their mathematics knowledge through discussion and activities.

Other Professional Development Opportunities and FMSP Events: The attendance statistics show that these are well attended and feedback from the exit evaluation forms show that teachers generally find their experience positive and beneficial. This was similarly the case for the FMSP Associates events and the Access to Further Mathematics events.

Student Tuition: The number of students receiving tuition directly from FMSP tutors has been decreasing over recent years, but this coincides with more schools/colleges now teaching Further Mathematics themselves. The FMSP believes the number will stabilise at about 400. Feedback from the students on the tuition they received was generally very positive with about 90% finding various aspects of their tuition to be at least good, if not excellent.

Schools/Colleges that offer Further Mathematics and Student Entries: The number of state establishments that offer Further Mathematics increased by 42, from 1261 in 2010/11 to 1303 in 2011/12. The number of students entering also continues to grow with a 7.9% and 4.3% increase in the number of students entering for the AS and A level respectively in these two years.

Conclusion: Phase 4 of the evaluation shows that the FMSP is continuing to provide services that students and teachers of Advanced level Mathematics and Further Mathematics find valuable. More so, the FMSP is developing its services to meet newly identified needs such as the recently introduced Live Online Lectures (LIL FM) and professional development for teachers that aims to enable them to support students who wish to take STEP and/or AEA examination papers. The growing influence of the FMSP in pre-16 mathematics education is also noted, and in particular the very positive response to professional development in the provision of enrichment opportunities.

The FMSP should continue to offer its well established services and events whilst developing those it has recently introduced, and should pursue opportunities offered by the partnerships and alliances with the Teaching Schools.
1. Introduction and background

1.1 Introduction to this evaluation
The current evaluation is the fourth in a series of evaluations carried out by the Centre for Evaluation and Monitoring (CEM) at Durham University, commissioned by the Further Mathematics Support Programme (FMSP). These evaluations have been designated as phases; the report on Phase 1 focused on the formation of the FMSP in August 2009 and the transition from its forerunner, the Further Mathematics Network (FMN). There have been two substantial evaluations subsequent to this with the most recent, Phase 3, reporting in May 2012. The Phase 4 evaluation considered a wide spectrum of FMSP activity and looked specifically at 14 aspects of its work as detailed below:

1. FMSP Area Coordinators; role, support and training
2. Live Online Professional Development (LOPD)
3. Sixth Term Examination Paper (STEP) and Advanced Extension Award (AEA) CPD
4. Live Interactive Lectures for Further Mathematics
5. Mathematics Stakeholder views on the work of the FMSP
6. Key Stage 4 Extension and Enrichment CPD
7. Awareness of FMSP in 11-16 schools
8. Characteristics of schools and colleges that offer Further Mathematics
9. Engaging with priority schools, Academies and Teaching Schools
10. The general impact of the FMSP
11. The relationship between Further Mathematics and University courses
12. Teaching Further Mathematics (TFM) and Teaching Advanced Mathematics (TAM)
13. Graded entries in AS and A level Further Mathematics
14. Feedback and participation statistics in FMSP services update

1.2 Background information about the FMSP
The Further Mathematics Support Programme, set up in 2009, is a government-funded initiative, managed by Mathematics in Education and Industry (MEI). It follows on from the Further Mathematics Network (FMN), also government-funded and managed by MEI, which was set up in 2005. The Further Mathematics Network was set up following a 5-year pilot project that was developed by MEI and funded by the Gatsby Charitable Foundation.

The FMSP aims to

- give every student who could benefit from studying Further Mathematics the opportunity to do so;
- increase the number of schools and colleges offering Further Mathematics;
- increase the number of schools and colleges able to teach Further Mathematics themselves;
- increase the number of students studying AS/A level Mathematics and Further Mathematics;
The FMSP has a central management and administration team as well as Area Coordinators working across the 9 English government regions, covering the whole of England. Area Coordinators are expert in teaching and learning mathematics at this level and experienced at working with mathematics teachers.

In addition there is an FMSP Wales, which is a Welsh Government funded initiative. It is managed by the Wales Institute of Mathematical and Computational Sciences (WIMCS), a collaborative partnership of the universities of Aberystwyth, Bangor, Cardiff, Swansea and University of South Wales. FMSP Wales is supported by MEI who manage the FMSP in England. FMSP Wales was initially funded from 2010-13, and has recently secured funding for a further two years from the Welsh Government.

The FMSP seeks to bring together schools, colleges, local authorities, teaching schools, universities and other local and national stakeholders to improve opportunities for students.

The FMSP promotes the uptake of AS/A level Mathematics and Further Mathematics through various activities and events which include:

- providing mathematical enrichment events and taster sessions to encourage and inspire students to study more mathematics;

- **providing advice and guidance to raise awareness amongst teachers, students and parents of the benefits of studying mathematics beyond GCSE**;

- encouraging university departments to promote the study of Further Mathematics in their offers and/or advice to applicants
2. Area Coordinators and their perception of the role

2.1 Background
There are 30 FMSP Area Coordinators (ACs). Each is responsible for FMSP activity in a sub-region of one of the nine government regions in England. The role of an AC is

- to liaise with and support local schools and colleges to help them set up, develop and sustain Further Mathematics courses for their students;
- to provide professional development opportunities for teachers to support this for students at both Key Stage 4 and A level Mathematics;
- to provide mathematical extension and enrichment opportunities for students in Key Stages 4 and 5.

ACs also have the task of prioritising contacting and working with schools/colleges which have been given ‘priority status’ (see Appendix A for definitions) in agreement with the Department for Education. These include both 11-16 and 11-18 schools/colleges, as well as post-16 institutions. There is a particular focus for Area Coordinators to engage with teachers and students in these schools/colleges in order to extend and improve their mathematics provision. These are referred to as Priority Schools in this report although this terminology isn’t used in any contact between such schools and the ACs.

2.2 Interviews with Area Coordinators
The evaluator contacted a sample of 10 ACs inviting them to participate in a telephone interview on their perception of their role and the support they are given by the central FMSP management and administration team. The sample chosen aimed to be representative of the 9 regions and the length of time that Area Coordinators have spent in post. However, it transpired that even some recently appointed ACs had had some involvement in the FMN and/or FMSP prior to their appointment. All had experience of teaching mathematics at either secondary or tertiary level. All 10 ACs contacted were interviewed. The interviews followed a pro-forma in which ACs were asked the following questions.

- How would describe your role within the FMSP?
- What interaction have you had with schools and colleges including Priority Schools?
- What support do you receive from the FMSP Central Team?
- By what measures will you judge the extent of your achievement in the role?
- Is your job manageable; what do you get personally out of being an AC?

How would describe your role within the FMSP?
The two ACs who been with the FMSP since the formation of the FMN in 2005, noted how the role had changed considerably since then, a view confirmed by many of the others. The initial focus of the FMN had been on AS and A level Further Mathematics and providing tuition for students who couldn’t access it at their school or college. The ACs noted that with the increase in the number of students taking both A level Mathematics and Further Mathematics, there had been a change in focus of their role. As more schools and colleges became able to support their own students the focus changed from providing tuition to encouraging interest in mathematics through enhancement and enrichment opportunities for students. The ACs are also involved in providing increased professional development opportunities for teachers to consolidate or
extend their knowledge of mathematics at post 16 level, and to increase their confidence to teach it. One relatively new AC highlighted the Priority Schools aspect of his role, and the need to make contact and engage with reluctant schools to help them identify their needs and how the FMSP might help.

**What interaction have you had with schools and colleges including Priority Schools?**

All the ACs noted there were large differences in how schools respond to invitations to become involved with the FMSP. In one sub-region all but two schools are now registered whereas in other regions large numbers of schools are reluctant to be involved, even some where Further Mathematics is well established. Many found the recent emphasis on 11-16 schools and Key Stage 4 enhancement and enrichment had generated a lot of interest, but some 11-16 schools didn’t understand why they had been contacted perceiving the programme to only be of relevance to schools/colleges that may offer Further Mathematics. Some schools and colleges continue to ignore emails and telephone calls; the ACs noted how invitation to an event, usually offered free, is one of the best ways to make initial contact. Once there is a named teacher in a school as a personal contact, discussion on help from the FMSP can be initiated. However, one AC from a London sub-region noted that there are many schools and colleges in the area that offer Further Mathematics and some that don’t are not concerned if they lose a few students through not offering Further Mathematics themselves, so show no interest in initiating it.

One AC, who is based at a university, noted how Key Stage 4 and 5 students attending an event in a university building found it special. Several ACs also noted the growing take up of professional development opportunities. All the ACs mentioned how organising events and meeting teachers at them helped to reinforce contact and engagement. Some ACs noted that in schools where the number of students taking Further Mathematics continues to be small, the continued support and the fall back position of the FMSP is most welcome should the school no longer be able to offer Further Mathematics ‘in-house’.

**What support do you receive from the FMSP Central Team?**

All the ACs responded very positively to this question. All ACs have a Regional Manager from the Central Team, to whom queries can be made; all said the response to any query was swift and helpful. Similarly, queries about administration and financial matters to the MEI Office resulted in swift and helpful advice. More formally, the ACs said they had regular meetings with their Regional Manager, which other ACs in the region would attend, for updates and discussion on event organisation and current FMSP thinking and direction. Many ACs also noted that members of the Central Team often visit and contribute to events in their region giving opportunity for discussion of any queries. Generally these ACs felt the support available to them was excellent and it was difficult to find any fault with it.

On training needs, the new appointees all mentioned the induction conference for new ACs in September 2012 they had attended, where the emphasis was on essential administrative duties, such as maintaining the student database. Otherwise they said, it was very much a case of “learn on the job” but with lots of help and advice available to facilitate that. One recently appointed AC described the resources for teacher professional development she received from the Central Team as excellent. She also has good support from a colleague when conducting her own professional development events. Other ACs noted the three events a year for ACs, which although not formal training, gave opportunity for discussion amongst ACs and with the Central
Team on strategies for supporting schools as well as opportunity to contribute views on the direction of the FMSP. Most noted they work closely with the other ACs in their region, particularly in joint event organisation or support, and their regular meetings with their Regional Manager.

**By what measures will you judge the extent of your achievement in the role?**

All ACs work in consultation with their Regional Manager and agree the number and types of event to offer in their sub-region. If planned events take place and are well attended, that will be one measure of success, and if the feedback from the exit evaluation forms is positive, that would be even better. On engaging with schools, all mentioned if they manage to bring some reluctant schools into FMSP involvement that will be a success for them, particularly if they can do this with at least some priority schools. Two ACs noted how schools will approach them for help for finding teachers who can teach Further Mathematics whilst others noted teachers often approach them for advice. This turnaround of who approaches who is a measure of success.

**Is your job manageable; what do you get personally out of being an AC?**

All the ACs said their job is manageable, but there are many aspects to it and they are always busy, often putting in more time than their formally allotted two or three days a week. Although most of the ACs have some administrative support available to them, they tend not to use it, except for financial matters which they can pass to a finance officer where they are based. Some noted that they can call on the assistance of an Associate when the demands of the job do become unmanageable. The recently appointed ACs noted they were getting better at managing their various duties as they gained experience. One noted her previous teaching and management experience had given her time management skills and she was able to prioritise. One very experienced AC noted how she likes managing her time, contrasting this with teaching where flexibility is limited by the timetable. Another experienced AC noted how the workload varies over the year, and she too likes the flexibility and the freedom to manage her own time.

When asked “why do you do this job?”, the two long serving ACs both said “because I love it”, adding the immense satisfaction they get from the role in helping schools, teachers and students alike with their particular needs, particularly when a positive response is received. Meeting with teachers and students and providing schools with what they value, was reiterated by other ACs, one of who said “the job is brilliant; I love it”. Another talked about her “brilliant colleagues” and “the feel good factor” she gets from the job, when she has had a positive outcome from working with a school. One mentioned how satisfying it was seeing pupils who come from a deprived background grow in confidence and self-esteem, through progressing in mathematics. Another AC, noted he realises just how many contacts in mathematics education he has made through being an AC, and that discussing mathematics education with them is a fulfilling part of the role. Another AC, who has another role as a consultant, noted her knowledge of Key Stage 3 and Key Stage 4 feeds into her work for the FMSP, and the latter also keeps her informed of developments at Key Stage 5. Some ACs did think they needed to prioritise their commitments mentioning it can take careful balancing of time, but all ACs clearly valued working with the FMSP Central Team, noting just how committed these people are to enhancing mathematics education. Most ACs would like to go full-time like the Central Team, but are reticent due to the uncertain long term future of the FMSP.
2.3 Conclusions
These 10 ACs are clearly highly motivated individuals who are committed in delivering on the various aspects of their role, of which they all have a sound understanding through ongoing training and updates. There is no reason to doubt that all the current ACs are similar in their desire to enhance the experience of both students and teachers as they help to develop mathematics education in their area and nationally.
3. Developments in FMSP Professional Development

3.1 Overview of professional development offered by the FMSP

A key aim of the FMSP is to contribute to the continuing professional development (CPD) of mathematics teachers. Over a number of years the FMSP has developed a comprehensive suite of options in order to best facilitate appropriate and suitable professional development opportunities to meet teachers’ needs. CPD courses offered by the FMSP may be short or long; face-to-face or online; at Key Stages 4 or 5 or at STEP/AEA level (Sixth Term Examination Paper / Advanced Extension Award). Attendance at CPD events is measured by the FMSP in teacher days. In 2011/12 well over 1000 teacher days of CPD were provided by the FMSP.

The Phase 3 evaluation detailed feedback on the two ‘long’ courses offered by the FMSP, namely the 14 month long Teaching Advanced Mathematics (TAM) and Teaching Further Mathematics (TFM) courses. Feedback from recent participants in these two courses is included in Section 6.

One-day continuing professional development (CPD) events usually focus on a particular A level module, or on a particular skill, such as the use of ICT, and are offered across the nine regions of England throughout each academic year. The FMSP facilitates a series of teacher networks across England each of which meets regularly. Feedback on both of these types of event can be seen in the report on Phase 2 of the evaluation.

Since 2008 the FMSP has developed provision of live online CPD - teachers attending interactive sessions in real-time via the internet. This is referred to as the Live Online Professional Development (LOPD) programme.

During 2012/13, the FMSP provided for the first time, CPD for teachers to support the problem-solving skills necessary for success in Sixth Term Examination Paper / Advanced Extension Award (STEP/AEA) examinations.

During 2012/13, for the first time the FMSP has provided a national programme of CPD events for teachers of Key Stage 4 Mathematics.

The professional development opportunities using LOPD, in STEP/AEA and in extension and enrichment for Key Stage 4 students are evaluated in this report.

3.2 The Live Online Professional Development programme

The Live Online Professional Development (LOPD) programme was set up to provide an alternative to attending face-to-face courses away from their school or college for teachers seeking to access professional development support. The LOPD programme is publicised to teachers as a way of improving subject knowledge.

In LOPD courses small groups of teachers meet online with a tutor for weekly live sessions. Although the main aim is to cover subject knowledge, some time is spent discussing pedagogy and exchanging teaching ideas. The sessions are delivered using the virtual classroom software Blackboard Collaborate which enables interaction between the tutor and the attending teachers via microphones, instant messaging via a ‘chat box’ and the facility to share written mathematics
visually on the *Blackboard Collaborate* screen, which can act as an online whiteboard. The online whiteboard can be used with both pre-prepared slides and also live online use of a graphics tablet.

A LOPD course consists of up to 10 sessions and each session lasts for between 60 and 90 minutes (the exact number of sessions and their duration and thus the cost of the course, is determined by the mathematics that is to be covered and the most sensible way to divide it into sections).

There are usually 5 or 6 teachers on each LOPD course as this number of teachers seems to optimise opportunities for interaction and discussion. Course sessions are scheduled to take place after the school day, usually from 4:30 to 6:00 pm. The sessions are recorded so that if a teacher misses a session they can catch up by watching the recording. The recordings are also available for the teachers to review the sessions and use them in their lesson planning.

### 3.2.1 Observation of two sessions

To gain a better understanding of how a LOPD session is delivered, the evaluator ‘sat-in’ on two sessions of a Further Pure Mathematics 1 (FP1) course, which covered the module requirements on matrices.

A commentary on the two sessions is in Appendix B.

Five teachers attended the sessions. Although the attendees had had an introductory session on using the virtual classroom and the facilities on *Blackboard Collaborate*, in both sessions these were gone through again, and the attendees were encouraged to introduce themselves and use a map of England to indicate where they were located. This gave a friendly and relaxed start to the session.

The presenter outlined what topics would be covered over the duration of the FP1 course, before focusing on matrices and what would be covered in this particular session.

The presenter assumed that the concept of a matrix was totally new to the teachers and the development was paced so that teachers had a chance to ask questions or respond to questions from the presenter via the instant messages or using the microphone. Interaction was encouraged by the presenter. The presenter made use of both prepared whiteboard slides for introducing and developing topics and the graphics tablet for demonstrating a live solution to a problem on the online whiteboard. The teachers were given problems to test their understanding at appropriate stages in the sessions which were then discussed. Teachers only had sight of each other’s solutions at the discussion stage if they wished to share them as they each had been assigned their own online whiteboard screen to do their working on. Typical examination questions were also presented and the solutions discussed. FP1 focuses mainly on knowledge of 2 x 2 matrices and their algebra and how they relate to transformation geometry. The second session ended with some suggestions for enhancement including some challenging problems and extension to 3 x 3 matrices.

### 3.2.2 Feedback from teachers who participated in LOPD

In the Autumn term of 2012/13, the FMSP offered 15 LOPD courses covering most of the modules of AS and A level Mathematics and Further Mathematics together with an online support programme for STEP. These courses were attended by a total of 95 teachers. A sample of teachers, representative of schools and colleges across England, were invited to participate in a telephone interview about their views on the course they attended; nine such interviews were conducted.
A pro-forma was used in each interview in which delegates were asked the following questions:

- Why did you participate in this particular course?
- What were your expectations; were they met?
- What was good; what could have been better?
- How has attendance affected your teaching?
- What were any sharing or dissemination arrangements with colleagues?
- How did you find the technology and working in a virtual classroom?
- Do you have plans for any future professional development?

**Why did you participate in this particular course?**

All nine teachers responded that they wanted to refresh their subject knowledge in the area of their course, as they were new to teaching it. Some were teaching the course whilst simultaneously taking the LOPD course, and ‘staying ahead of the students’. Two mentioned that the LOPD courses had been recommended by a colleague. One teacher was taking a LOPD course as part of his TFM course; he was taking the TFM course to extend his knowledge across more Further Mathematics modules as he wanted to develop Further Mathematics in his school.

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

These teachers generally wanted to gain a better understanding of the mathematics of their course topics and so be able to answer students’ questions with confidence. They also wanted to be introduced to and shown classroom use of the resources on the Integral website and how this integrated with lesson planning. Delegates were agreed their expectations were met; this varied from comments such as “it was really, really good” and “absolutely” to just one comment on the content being “adequate” although this teacher found other aspects of the course, such as student misconceptions to look out for, to be good.

**What was good; what could have been better?**

Five of the teachers highlighted that they found the presentation of their course to be good and thought that the presenters were well prepared. One noted the willingness of the presenter to answer questions. One teacher highlighted the ideas for teaching topics and how common student misconceptions were brought out. She particularly liked the approaches presented and said they would get students thinking. One teacher, who had not taught any statistics before, noted how the presenter had brought the material ‘to life’, and made it interesting. One noted that the structure of the course was good, saying it flowed with a good fit to the scheme of work, whilst another commenting on the same thing, noted it was preferable to the structure in the textbook. Most teachers mentioned the opportunity to work on some appropriate problems themselves and then share their solutions with each other and the tutor, as this is how they would work with students. One teacher summed up his experience as having found his course to be integrated and consolidated in terms of knowledge, how to teach topics and use resources; he felt able to help his students to tackle ‘real world problems’.

---

1 The Integral website has been developed by MEI and now provides an extensive online learning environment of mathematics resources for A level Mathematics and Further Mathematics. Any school/college which is currently registered with the FMSP receives teacher access to the resources for the pure and applied modules of A level Further Mathematics, free of charge.
One teacher had hoped for more on how to teach topics and another had experienced technical problems but the general consensus of the participants was that the course attended had been really good, relevant to their needs and they had enjoyed it. One actually wanted the course to be longer whilst another would have liked more time to spend on hands-on activities. One teacher did think on his course there had been too much emphasis on knowledge as opposed to teaching topics whereas another on a different course found the opposite.

How has attendance affected your teaching?
All the delegates said they were currently using, or intended to make use of, the knowledge and ideas for teaching met on their course. One noted he was moving away from ‘chalk and talk’ to a mix of activities and group work whilst another noted he is having to adapt the ideas to fit with the teaching time he has available. Three teachers again mentioned their increased confidence to respond to questions from students, and another noted how teaching the content whilst actually attending the LOPD course enhanced his understanding of the mathematics. Most mentioned more active uses of the resources including the PowerPoint slides used in the presentations. One teacher noted especially being introduced to the software package ‘GeoGebra’ saying he was convinced by it and was integrating it into the teaching ideas he had got from the course and was using. He also highlighted that students realised he was more confident as their teacher, and they responded positively to that, and their own confidence with the mathematics was increasing.

What were any sharing or dissemination arrangements with colleagues?
Many had colleagues who had taken a LOPD course previously, and had discussed the advantages of this approach and what they had got from the experience. Some teachers who had taken a Further Pure Mathematics module noted they were the only teacher capable of teaching the topic, but some said they intended to induct colleagues into doing so.

How did you find the technology and working in a virtual classroom?
Apart from a few rare technological troubles, such as losing contact for a while or a software package that wouldn’t load, the teachers had no problems with the technology. They liked the LOPD mode of delivery, with the sessions timed at the end of a school day so they could access them from home if they wished, and they found a prolonged course of several sessions preferable to a ‘one-off’ face-to-face event as the LOPD course allowed reflection time between sessions and opportunity to bring up queries for discussion at the next session. One liked discussing ‘with strangers’ via the ‘chat box’ facility, finding it an advantage not actually being face-to-face as it wasn’t threatening and she had no inhibitions about asking questions, whereas another was content to “sit and listen”. Several teachers noted there was no disruption to their teaching day, and no travel arrangements were necessary. The teachers generally found the length of the sessions and their scheduling to be about right. One said the LOPD course was very convenient for him in its scheduling and another noted it fitted well with her domestic arrangements.

Do you have plans for any future professional development?
All these teachers said they would like to do another LOPD course and extend the modules they are able to teach. One said she now intends to sign up to the Teaching Further Mathematics (TFM) course. Many reiterated the recommendation they had made to colleagues. Most too noted that they had financial support from the school or college management for LOPD courses. One

---

2 It should be noted the LOPD courses are advertised as primarily covering subject knowledge.
commented that it was a “win-win” situation for her and her school, as there were no travel and cover costs and it was a good value for money course at a convenient time of day. One teacher noted the positive impact of the course on him and his students and that he intends to join them at revision sessions.

**Feedback from the end of course evaluation forms**

At the time of this analysis 41 feedback forms have been received from teachers who participated in a LOPD course in the Autumn term of 2012. This is about 46% of those who participated in the 13 courses that ran.

Delegates were asked to rate four aspects of the event on a four point scale

where 4 is excellent    3 is good    2 is adequate    1 is poor.

The results are shown in Table 3.1

<table>
<thead>
<tr>
<th>Aspect of the course</th>
<th>mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information you received in advance of the course</td>
<td>3.6</td>
</tr>
<tr>
<td>The course content and resources</td>
<td>3.7</td>
</tr>
<tr>
<td>The course delivery</td>
<td>3.6</td>
</tr>
<tr>
<td>Overall suitability of the online classroom</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 3.1 shows a summary of the scores. On each of the four aspects the mean score is 3.6 or 3.7, showing participants rated all aspects of their LOPD course to be at least good with many of them finding them to be excellent.

The participants were also asked whether the course had met their expectations and whether they would recommend the course to other teachers.

<table>
<thead>
<tr>
<th>Did the course meet your expectations?</th>
<th>Responses</th>
<th>Recommend to others?</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better than expected</td>
<td>28</td>
<td>Yes</td>
<td>41</td>
</tr>
<tr>
<td>Less good than expected</td>
<td>1</td>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>What I expected</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Table above indicates that about 68% of the participants who returned an exit evaluation form found the course to be better than they had expected, with only one participant finding his course to be less good than expected.

**3.2.3 Conclusions**

In the interviews, phrases like, “it was really good” and “I really enjoyed it” were common when teachers were asked to summarise their feelings from having taken a LOPD course. One teacher said she had been “really impressed” and another that “this approach should be used more”. Although nine teachers is a relatively small sample, there is a consensus from the teachers interviewed that taking a LOPD course is a very worthwhile experience that has enhanced their teaching.
The feedback from the 41 participants across 13 courses shown in Table 3.1, supports this view with many rating the various aspects of the course as excellent, and again only one participant rated any of the aspects as adequate. It is notable that all of these participants would recommend the course to other teachers, which adds to the conclusion that the LOPD courses are a very successful format for continuing professional development. The FMSP should look to expand and develop their LOPD provision.

### 3.3 Sixth Term Examination Paper/Advanced Extension Award

#### Professional development for teachers

The Sixth Term Examination Paper comprises problems based on the content of A level Mathematics and Further Mathematics specifications which seek to test a candidate’s more advanced problem-solving skills through less-structured, longer and deeper questions. Success in STEP examinations is a requirement of some universities for entrance to their undergraduate mathematics and other courses. The Advanced Extension Award is similar in that it requires students to have developed a deeper understanding of the mathematics and to have further developed problem-solving skills.

A national programme of STEP / AEA professional development courses has been offered during 2012/13. The programme consists of 21 face-to-face events but the course was also offered to teachers as an online course using the LOPD model for those unable to attend a face-to-face event. Records are available for 18 of the 21 face-to-face courses so far. A total of 292 teachers have attended these 18 events.

#### 3.3.1 Observation of a STEP / AEA professional development event

The presenter in introducing himself highlighted that it was a pleasure for him to work with gifted and talented students at this level, and for the event he invited the teachers to bring up and discuss any points they wished to. Although there was a programme for the day, he hoped it could be flexible. He invited the delegates to introduce themselves and say why they were there; all were there because they had students who wanted to take the STEP papers and they wanted advice and resources on how to support them. It was notable that the emphasis was on STEP rather than the AEA.³

The delegates were each given a pack for the event entitled ‘Developing sixth formers’ mathematical problem solving skills’ which included a booklet of problems, hints for solving them that might be shared with students, and actual solutions. These, developed by the FMSP specifically for the event, would be used during the day. The presenter highlighted how important it is to enter into dialogue with students who are attempting to solve the sort of problems set on STEP papers. He emphasised that help should be kept to a minimum, but teachers shouldn’t be discouraging.

---

³ In the initial piloting of professional development for STEP and AEA it became apparent that teachers were primarily interested in STEP and thus the emphasis on STEP in the events.
The programme for the day consisted of:

- A historical perspective on the origins of STEP and AEA.
- The problem solving mind-set and the contrast between STEP / AEA and modular examinations.
- Hands on problem solving using the supplied delegate pack.
- Extending a topic in A level mathematics.
- Advice and discussion on resources and setting up support in school.

A commentary on the activities of the day is in Appendix C.

3.3.2 Feedback from teachers who attended a STEP / AEA event

Feedback from delegates was obtained in two ways. This was by invitation by the evaluator to selected delegates to take part in a telephone interview, and also by summarising the results of the feedback collected via exit evaluation forms at the end of each event by the FMSP.

Telephone interviews

The FMSP supplied the evaluator with an extensive list of teachers who had attended a STEP / AEA event. Of these a sample representative of the nine regions of the FMSP were invited to take part in a telephone interview. A total of seven interviews were conducted.

All interviews followed a pro-forma that included the following questions:

- Why did you participate in this event?
- What were your expectations; were they met?
- What was good; what could have been better?
- How has attendance affected your teaching?
- What were any dissemination arrangements with colleagues?
- What was your general view of the day?

Why did you participate in this event?

These seven teachers had contrasting reasons for attending but in general they wanted to be able to support students they currently had who were interested in taking STEP or finding out about the requirements of STEP for students they may support in the future. One teacher had a school wide responsibility for gifted and talented students and wanted to use STEP to enhance opportunities for such students in the sixth form.

Another teacher has a student with a current offer from Cambridge to read mathematics and she wanted to find out what appropriate support she could offer. One teacher was in what must be a fairly unique situation; she was from an 11-16 school, where a Year 9 student will take A level mathematics this year, and she was looking for ways to stretch this young able student intellectually on the material she was currently studying, noting that would enhance the likelihood of her achieving a high grade at A level.

What were your expectations; were they met?

The teachers all expected to get support and advice on working with students and were agreed that expectation was met. Amongst the comments made by the delegates were the resources were of a high quality, there were lots of ideas for stretching students and keeping them engaged with
mathematics and the information on how STEP works was very useful. Most mentioned they wanted to be better informed about the requirements of STEP and how to teach and prepare their students to take these papers and were agreed this objective was achieved.

What was good; what could have been better?
The teachers generally liked the opportunity to do the mathematics problems from the delegates’ pack and to compare their approach with those of colleagues. One commented that the level of mathematics required was just at the right pitch and the emphasis was on thinking skills and solving unfamiliar types of problem but using topics from the main A level course and even GCSE topics. Two teachers mentioned they liked the way the presenter helped them engage with the mathematics through hints “look at it this way”; or “try this”, this being seen as the sort of help they would offer their own students.

There was little by way of criticism, but one teacher thought the historical background, although interesting, was rather too long. Another teacher thought it would have been helpful to have been sent some problems in advance of the event. He was particularly interested in trying to find out what the setters of the STEP papers were looking for in the candidates, noting there wasn’t a specification.  

How has attendance affected your teaching?
One teacher said he now felt confident in guiding and supporting students on the STEP I paper, without recourse to an FMSP course, but he would still send STEP II and III students on such a course although he would be able to support them himself in school. The teacher of the young gifted student said this student was very conscious of not wishing to be a ‘geek’ and so the teacher would let her work on STEP problems in the mathematics lessons supporting her as necessary. This student intends to take Further Mathematics while still at the 11-16 school. The teacher with school wide responsibility for gifted and talented students, noted that he runs a session for them weekly and has identified students who could potentially go to Cambridge to read mathematics; he is looking to give them one-one support. He is also attending sessions on STEP put on for students and teachers by the local FMSP Area Coordinator. Another teacher mentioned that she is now much more confident in giving help and advice and appropriate hints to students who are stuck in a problem. One teacher, who is not currently teaching STEP students, did raise the question, that although he can see STEP and the Further Pure Mathematics modules have different requirements, in what way does STEP go beyond the A2 modules of C3 and C4?

What were any dissemination arrangements with colleagues?
Two teachers said they had shared the resources and discussed the day with interested colleagues, and those currently teaching Further Mathematics. One teacher noted that she wanted to bring such colleagues into helping to support potential STEP students. The teacher from the 11-16 school noted this level of mathematics was beyond her colleagues but she was grateful to receive more material after the event. One teacher was planning an in-house professional development day for teachers of gifted and talented students and he would put a resource pack together for that.

---

4 There is a specification for STEP which is available via the Cambridge Assessment website.
5 There are three STEP papers, **STEP I, STEP II and STEP III**. Candidates are usually required to sit either one or two of these examinations, depending on the requirements of the universities they have applied to.
6 This is detailed in the STEP specification which is available via the Cambridge Assessment website.
What was your general view of the day?
All the teachers had found attending the event worthwhile and they had enjoyed the day. One teacher, who is currently working as an FMSP Associate, noted she hopes to put on another STEP day in the local area noting there are lots of schools who are interested. Another teacher noted this had whetted his appetite for mathematics beyond standard A level and he hoped to become a Further Mathematics teacher; the evaluator brought the TFM course to his attention, which he intends to follow up. One teacher mentioned that she now has four years’ experience of teaching Further Mathematics and has brought colleagues into teaching it and she hopes now to follow this with STEP mathematics. She noted that she realises now the importance of helping students to solve problems themselves, rather than doing a problem for them.

Feedback from exit evaluation forms
At the time of the analysis – from the delegates who attended these events 282 exit evaluation forms were received from a total of 292 delegates. The average attendance across the events was 16 delegates.

Delegates were asked to rate four aspects of the event on a four point scale where 4 is excellent 3 is good 2 is adequate 1 is poor.

The results are shown in Table 3.2

<table>
<thead>
<tr>
<th>Aspect of the event</th>
<th>mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course content</td>
<td>3.4</td>
</tr>
<tr>
<td>The course delivery</td>
<td>3.4</td>
</tr>
<tr>
<td>The venue and refreshments</td>
<td>3.3</td>
</tr>
<tr>
<td>Information you received in advance of the event</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Table 3.2 shows a summary of the scores. On each of the four aspects the mean score is at least 3, showing delegates found these aspects of the event to be at least good, with many of them finding them to be excellent.

3.3.3 Conclusions
The STEP / AEA event observed was a demanding day for the delegates as it covered a lot of ground, but this event clearly met a need as evidenced by the number of delegates attending the events held around the country. Both the telephone interviews and the exit evaluation forms indicate these events have been successful in meeting their objective, of providing advice and resources so that teachers can support their students. Students should be better prepared for STEP / AEA examinations as a result of their teacher attending and more students should have opportunity to take these papers if they wish.
3.4 Extension and Enrichment for Key Stage 4 Students

Professional development for teachers

3.4.1 Background and extension and enrichment events

Since 2010, the FMSP has run a national series of mathematics enrichment events for students in Key Stage 4. These events aimed to inspire students in mathematics through seeing the subject in challenging problem solving perspectives that they would not normally meet in the classroom. The aim of these events was to encourage the students to consider continuing to study mathematics after completion of their GCSEs through taking AS and A level Mathematics and Further Mathematics post-16.

In 2012/13, the FMSP held professional development events for teachers in 21 venues around England so that they may acquire resources and ideas with which to deliver extension and enrichment sessions to their own students. These events were aimed particularly towards students who were studying at Higher Tier GCSE. The aims as specified on the FMSP website were to:

- Familiarise teachers with a range of FMSP, MEI and other resources designed to extend and enrich the mathematical experiences of Higher Tier GCSE pupils.
- Enable teachers to develop strategies to address the challenges of working with all Higher Tier GCSE pupils.
- Provide teachers with an opportunity to integrate these materials within their departments and schemes of work.

The event in each venue was held over two days, separated by several weeks, ‘the gap’. This was to enable delegates to gather resources and teaching strategies from the first day, which they could share with colleagues and try out with their students at school and on the second day to share their experiences and reflect upon them in discussion with other delegates and the course presenters. There was some online support available to delegates during ‘the gap’. The first day gave teachers an opportunity to try out resources developed by the FMSP and others for themselves and discuss them with other teachers present. It is notable that all the events were over-subscribed indicative of the considerable level of interest teachers have in this aspect of mathematics education.

3.4.2 Observation of an Enrichment and Enhancement event

The event was split into 10 sessions, with 5 sessions on each of the two days. The 10 sessions were:

1. Course structure and expectations / Mathematical activities
2. Card sort and discussion
3. Extended mathematical activity and discussion
4. Other sources of resources
5. Planning and gap tasks
6. Feedback and strategies
7. Using real contexts as an approach to challenging students
8. Teacher’s own tasks / other GCSE extension materials
9. Embedding extension and enrichment material within departments and involving others
10. Resources wish list
The event was hosted by the local FMSP Area Coordinator. There were two presenters at the event, both members of the FMSP Central Team, one of whom had developed the resource materials and as such she was very familiar with them and had ideas for using them in the classroom. There were 20 delegates present on Day 1. It was noted that across England about 400 teachers were experiencing this event and there was a waiting list of another 200 teachers.

Throughout the two days, the presenters stimulated the delegates with questions and encouraged them to interact with each other in discussing responses. The delegates were also continually encouraged to think about classroom practice and how this might be developed in the circumstances in their own school. Delegates were offered various pro-formas to help them focus their thoughts and to keep a written record of their experiences and intended plans resulting from having attended the event.

A detailed commentary on the two days is at Appendix D.

In terms of meeting its objectives, the event observed was judged to be very successful, although on the second day, only eleven delegates were able to attend due to commitments at their school. The missing delegates would be offered a separate Day 2 session. Throughout the two days, the teachers present participated with enthusiasm and commitment. They were engaged with the activities and willing to share their thoughts and feedback on Day 2 from their own experiences in using the materials themselves and sharing them with colleagues at school.

3.4.3 Feedback from interviews with attendee teachers

Despite about 400 teachers attending the Enrichment and Extension events across the country, it actually proved quite difficult to find teachers who were prepared to find the time to give an interview on their experience of the event. This is possibly a reflection on how busy teachers are in their own schools. Ultimately 14 interviews took place, with delegates from seven different events.

The interviews followed a pro-forma in which delegates were asked the following questions:

- Why did you participate in this event?
- What were your expectations; were they met?
- What was good / what could have been better?
- How did you find the timing of the two days?
- What did you do in the period between the two days?
- How has attendance affected your teaching?
- What has been the response from students?
- What were any dissemination or sharing arrangements with colleagues?
- Are there plans for sustainability and integration into your scheme(s) of work?

**Why did you participate in this event?**

Teachers had a variety of reasons for attending this event, not least the fact that there was no charge and cover had been paid for. Some teachers, or a colleague, had been to an FMSP event before and found it very useful, so had come expecting this event to be similar. Most teachers were looking for good resources with which to stretch their Higher Tier students. One teacher noted she wanted to develop the problem solving skills and strategies of her students and sought advice on
how to do this. Some other teachers just mentioned that they wanted to improve the achievement of their students, and encourage them to aim for the A and A* grades. Others mentioned that they had some very able students and wanted some resources to stretch them. A teacher from an FE college was looking for ways of showing his students a new approach to learning mathematics. Other teachers made similar statements, in that they wanted some fresh ideas and resources, one teacher saying she was tired of using her own. One teacher noted how she thought enrichment was more important than accelerating her students noting the need for breadth of experience in preparing for A level study. Another teacher noted his school was having a ‘big push on stretch and challenge’ and he was looking for new ideas and resources for the Key Stage 4 students.

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

Most of the teachers partially answered this question in terms of their expectations in their reason for attending. All the teachers thought that their expectations had been met. One, who had travelled a long distance to be present, said it was very worthwhile her coming; she valued the opportunity to explore the material properly and do some mathematics with likeminded colleagues. Another teacher, who has a responsibility for developing a problem solving approach from year 7 onwards, noted she has ideas to try and reflect upon in developing this approach. One teacher from an 11-16 school noted she had gleaned ideas for encouraging students to take mathematics post-16. One teacher noted how she had been enthused by the event whilst another described it as very useful and refreshing. Another said he came looking to share resources and ideas, and to find new initiatives and he very much got that. One teacher described her experience as wonderful, and that she had got some really good ideas and resources, a view reiterated by several others; one teacher described the resources as brilliant. One teacher noted that she was using the activities as something a little bit different after teaching examination questions, but was using them as reinforcement. Several teachers commented that the event was really well organised, with good delivery and it was successful.

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

There was little criticism with most teachers reinforcing that the event had met their expectations in all aspects of the objectives. One teacher commented she didn’t like the way the *Integral* website is organised, but that wasn’t a criticism of the event itself. One teacher noted she had hoped for resources to use with a wider range of students as she had few in the gifted and talented category. However, most teachers highlighted the opportunity to work with other teachers and discuss ideas for how to help students make the transition to the problem solving approach. One teacher noted how keeping the number of delegates small, under 20, had had led to some high quality sharing and discussion. Another teacher described the event as inspirational with refreshing ideas that would help him avoid routine approaches to topics in future whilst another said he came away with ideas for further development. One teacher described the presenters as brilliant and the event as ‘career turning’; as well as gathering a lot of ideas and resources she had had a lot of fun working with other teachers. One teacher highlighted how good it was to meet and work with teachers from other schools.
How did you find the timing of the two days?
What did you do in the period between the two days?
The teachers did like having the ‘gap’ one describing it as a good feature of the event and most had tried some ideas with top sets in Years 9, 10 and 11. Another said that having the two days resulted in ‘the sum being greater than the parts’ and that preparing for Day 2 had helped him to focus on what he had achieved so far. Some did find the timing of their particular two days prevented them doing as much as they would have liked, due to commitments such as preparing for examinations or it didn’t fit well with their scheme of work. However, a teacher from one event noted how everyone had ‘done some homework’ and was prepared to share their experiences on Day 2. Some had looked for and made use of resources online and others mentioned staying in touch with other delegates via the networking forum. Another teacher highlighted the benefit for her of sharing feedback on Day 2, and that she took away ideas to ‘tweak’ resources to be more suitable for her own school. Some noted how they had already shared some ideas and resources with their colleagues and were generally encouraging the self-discovery approach for students that had been met in the event.

How has attendance affected your teaching?
What has been the response from students?
All the teachers noted that they had changed at least some of their teaching to explore this new approach. One contrasted the conventional ‘sit and listen’ lesson with this active approach noting there was a lot of noise in the classroom but mostly the students liked it with relatively few ‘out of their comfort zone’ when given an open ended, challenging, investigation. Most reported this sort of level of response in which most students they had tried the approach with, had responded positively. Several teachers noted the willingness of the students to engage and that some problems and resources were sparking the students’ interest, noting the need to identify such problems for future use whilst possibly amending others. One teacher noted she has offered her students a choice of doing an activity or working from a textbook. One teacher highlighted how at first her students were ‘horrified’ to be stuck, but after some guidance on coping with being stuck, students now actually ask not to be given any hints and they want to solve the problem themselves. Another teacher noted that her students did struggle with getting things wrong but she had persevered and thought the students were benefitting from some of the activities she had given them and getting them to discuss the problem was valuable in itself. One teacher noted how she has been ‘tweaking’ the resources to use with less able students whilst developing some of her own. She noted that whilst top set students take readily to the active learning approach weaker students need some persuading that they will benefit from it; they soon lose enthusiasm if they make little or no progress. One teacher noted that an activity she had tried had worked really well with her Year 10 students with them all involved and challenged by something different to a routine lesson.

What were any dissemination or sharing arrangements with colleagues?
Some teachers had made a presentation at a departmental meeting on their experience from the event and the resources they now had available, whilst others had at least talked about it to some of their colleagues. In most of the schools, other teachers who hadn’t attended the event, were trying out some of the activities and looking at ways of developing them for other students. These teachers were generally receptive to the ideas and enthusiastic about trying them out.
Are there plans for sustainability and integration into your scheme(s) of work?
The general response to this question was ‘yes’ that is the intention, but it would take a while depending on circumstances. One school planned to start with integrating this approach into the Year 11 scheme of work, whilst in another school the plan is eventually to integrate into every year group; this approach was mentioned by others as well. Some teachers noted how they will keep discussing this approach and how best to introduce it with various groups of students at departmental meetings. Some noted the need to find a balance between more traditional approaches and the problem solving approach, noting the latter may not be suitable for all students. Certainly in the schools that the teachers interviewed represent, the problem solving and active learning approach looks sustainable into the future, as all are, to a greater or lesser extent, looking to integrate it into schemes of work. The recognised barriers to such development are reluctant students and/or reluctant teachers, but there appears to be considerable discussion and development of ideas and resources going on in these departments, so that as far as the reluctant teachers are concerned, the problem will probably be overcome. It also seems likely that if this approach is introduced to students in Year 7, or possibly in primary schools, then it will become the norm.

Conclusion
The feedback from these teachers is very positive. They have clearly got a lot out of attending these events, and through their attendance, so have their schools. The objectives of the course as expressed in Section 3.4.1 above have been met for these teachers. Given the enthusiasm of the teachers at the observed event as well, that is probably quite universal amongst the delegates and is borne out by the summary of feedback from teachers at all the events given in Section 3.4.3 below. Sustainability into the future looks probable, but whether this approach will encourage students who otherwise at age 16 would not have opted for A level Mathematics, to opt for it, cannot be answered until this approach becomes widely embedded as normal practice pre-16.

3.4.4 Summary of teacher feedback from event exit evaluation questionnaires
At the end of the second day, delegates were asked to complete an exit evaluation questionnaire.

Delegates were asked to rate four aspects of the event on a four point scale where
4 is excellent    3 is good    2 is adequate    1 is poor.

The four aspects were:
- The course content
- Course delivery
- Venue and refreshments
- Information received in advance of the course

The results are shown in Table 3.3
Table 3.3  Feedback from teachers who attended the extension and enrichment CPD events

<table>
<thead>
<tr>
<th>Venue</th>
<th>The course content</th>
<th>Course delivery</th>
<th>Venue and refreshments</th>
<th>Information received in advance of the course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kingston</td>
<td>3.9</td>
<td>3.7</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Luton</td>
<td>3.1</td>
<td>3.4</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Brighton</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>3.1</td>
</tr>
<tr>
<td>York</td>
<td>3.7</td>
<td>3.3</td>
<td>3.6</td>
<td>3.4</td>
</tr>
<tr>
<td>Halifax</td>
<td>2.2</td>
<td>2.6</td>
<td>2.9</td>
<td>2.8</td>
</tr>
<tr>
<td>Bodmin</td>
<td>3.5</td>
<td>3.7</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Faversham</td>
<td>3.4</td>
<td>3.5</td>
<td>3.1</td>
<td>3.5</td>
</tr>
<tr>
<td>Chippenham</td>
<td>3.7</td>
<td>3.7</td>
<td>3.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Hull</td>
<td>3.4</td>
<td>3.1</td>
<td>2.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Newcastle</td>
<td>3.8</td>
<td>3.8</td>
<td>3.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Loughborough</td>
<td>3.6</td>
<td>3.7</td>
<td>4.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Tower Hamlets</td>
<td>3.9</td>
<td>3.9</td>
<td>3.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Poole</td>
<td>3.7</td>
<td>3.8</td>
<td>3.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Keele</td>
<td>3.6</td>
<td>3.5</td>
<td>3.3</td>
<td>3.1</td>
</tr>
<tr>
<td>Lancaster</td>
<td>3.6</td>
<td>3.6</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Liverpool</td>
<td>3.7</td>
<td>3.7</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Southend</td>
<td>3.8</td>
<td>3.8</td>
<td>3.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Manchester</td>
<td>3.5</td>
<td>3.7</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Birmingham</td>
<td>3.8</td>
<td>3.6</td>
<td>3.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Reading</td>
<td>3.9</td>
<td>3.7</td>
<td>3.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Sheffield</td>
<td>3.8</td>
<td>3.7</td>
<td>3.5</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Summary   | 3.6                | 3.7             | 3.5                    | 3.4                                           |

With the one exception of the event in Halifax, delegates in general in the other 20 venues rated each of the four aspects of the event to be at least good, as seen in average scores which are well in excess of 3 (good).

However, in the light of feedback received from the FMSP Area Coordinators and Associates who had been involved in delivering these events, there will be some changes made before the events are offered again in 2013/14. Some of the quotations used to illustrate issues on Day 1 will be updated to include new reports and publications, and will also include reflections on mathematics education in some other countries. There will be a new activity, from *n-rich*, included in the ‘resources from other sources’ on Day 1, and this will tie in with some new resources on the *Integral* website. On Day 2 there will be more guidance on the feedback rotation sessions, and there will be less time spent on the session on dissemination to others. A new session will be added to Day 2 on changes to the National Curriculum and the nature of proof. Most teachers found the first round of these events to be at least good, so these changes should make the next round events for teachers, even better.
3.4.5 Extension and Enrichment Conference – February 2014

The evaluator attended this conference together with over one hundred teachers and some locally based Area Coordinators and Associates and some members of the FMSP Central Team; the conference was oversubscribed. This was a full day conference and included teacher led workshops in the morning, activity workshops in the afternoon and two plenary sessions. Delegates had to choose two out of five workshops to attend in the morning and similarly in the afternoon. The morning sessions gave opportunity to see a range of problem solving activities that had been tried with Key Stage 4 students and to see some examples of students’ work. Teachers in each session were able to discuss these problems with each other and the workshop leader. The workshops in the afternoon covered a wider range of resources and issues, but again the delegates had the opportunity to be engaged in activities and discussion of any issues arising. The first plenary session, delivered by the MEI Programme Leader for Curriculum, focused on the changes to GCSE to be implemented from 2016, emphasising where now focus was moving towards problems solving skills. The conference ended with the second plenary session, in which an initiative on developing problem solving skills in students in the United States was presented with examples of the activities and their development.

Initial analysis of the evaluation feedback forms delegates were asked to complete at the end of the conference, showed the teachers to be extremely positive about the conference; 96% of the delegates rated the content and resources as good or better, with 99% finding the delivery to be good or better. Teachers who attended the conference had the opportunity to gather a wealth of ideas for activities and resources that they can adapt for their own schools and students. The evaluator engaged several of the delegates in casual conversation about their views on the event and also the professional development event if they had attended one. These teachers were all very receptive to the problem solving approach to teaching and learning mathematics, and were using it in their own classrooms as well as sharing the ideas and encouraging others to do likewise. They generally found the response of the students was positive. This was very much in accord with the telephone interviews with delegates to the professional development events, discussed in Section 3.4.3.

3.4.6 Conclusion

These series of professional development events and the subsequent conference have clearly been very successful. Teachers have rated them very highly. The teachers who attended have embraced the problem solving approach to teaching and learning mathematics and are developing it to meet the needs of their own schools and students. These teachers show considerable enthusiasm for this approach and it seems that in many schools it will be developed to include more than just the more able students at Key Stage 4. In some schools it will be implemented into the scheme of work across the whole school.
4. Developments in FMSP Tuition

4.1 Overview of FMSP Tuition

The FMSP arranges tuition in Further Mathematics for students in schools/colleges that cannot provide a course ‘in-house’. Tuition is provided in two ways:

- **Face-to-face tuition** – an FMSP tutor provides sessions covering materials in a module, usually weekly, in the student’s school or some other venue local to the student.

- **Live Online Tuition (LOT)** – live sessions covering a module are provided online, usually weekly, to small groups of students (typically fewer than five. The sessions are delivered using the virtual classroom software **Blackboard Collaborate** which enables interaction between the tutor and the students via microphones, instant messaging via a ‘chat box’ and the facility to share written mathematics visually on the **Blackboard Collaborate** screen, which can act as an online whiteboard. The online whiteboard can be used with both pre-prepared slides and also live online use of a graphics tablet.

Since 2011 the FMSP has also been offering Live Interactive Lectures for Further Mathematics (LIL FM). These live lectures are provided online, usually fortnightly, and are intended to introduce students to the content of a particular module. However, interviews with teachers who have students who have used LIL (see Section 4.2.2) indicated that some do preparatory work with students before a lecture. Interaction is via the use of the ‘chat box’ and other interactive facilities of the **Blackboard Collaborate** software. Teachers at the schools and colleges the students attend are provided with accompanying teaching materials which they can use in class in between the lectures. In contrast to face-to-face tuition and LOT, in this arrangement the FMSP is offering a resource to schools in the form of the lectures and associated resources rather than taking some responsibility for the progression of students through a course.

Feedback from students through surveys and interviews about the tuition they received from the FMSP can be seen in the reports of both the Phase 2 and 3 evaluations. LIL FM was introduced in 2011 as a resource to help schools/colleges support students who wish to study Further Mathematics; this is the first evaluation that has reported on it.

4.2 **Live Interactive Lectures for Further Mathematics (LIL FM)**

Live Interactive Lecture courses support many modules for all four English examination boards. Some courses consist of around 12 lectures and run across the whole academic year. Some courses consist of around 7 lectures and take place within a single term. The courses are delivered using the virtual classroom software, **Blackboard Collaborate**, which allows students to access them from school, college or home or wherever they have internet access. The fortnightly course sessions are typically one hour long and take place in the early evening.

Schools and colleges pay a small fee for their students to attend the sessions. This also gives the school/college access to accompanying teaching materials designed to be used in between the lectures. Students also have access to the online resources available through MEI’s **Integral** website. The lectures focus on introducing the content of the module. It is expected that students will work with their teacher in between the lectures taking advantage of the fact that they already have been
introduced to ideas during the lectures. It should be made clear that the FMSP is not responsible for how a school/college decides to make use of the lectures. Although schools/colleges are strongly encouraged to provide as much support as they can between the lectures, some may choose to provide relatively little formal support in this time and largely rely on the students’ learning independently. The FMSP reports to schools/colleges on their students’ attendance at the online lectures but it is made clear that it is the responsibility of the school/college to ensure students’ attendance and not the responsibility of the FMSP.

All sessions are recorded which enables a student to watch a recording if they missed the live session or to review a session. Recordings are made available to students’ teachers and tutors too.

4.2.1 Observation of two sessions
The evaluator observed the recordings of two live sessions, both on the topic of complex numbers. The first of these was the very first session in a series of lectures on a Further Pure Mathematics 1 module and the second session was a lecture midway through a series of lectures on a Further Pure Mathematics module for a different examination board.

Comprehensive details of the techniques used and the topics covered can be seen in Appendix E.

4.2.2 Feedback from teachers
Contact details of some teachers who have students who are attending LIL FM sessions were supplied to the evaluator. Of these, six responded to the invitation to be interviewed by telephone, about how their students find the sessions.

One of these six teachers, explained that out of the two students she had signed up to LIL FM, one had dropped out after one session, and the other was following a course as a distance learner, so she wasn’t in regular contact with the student. However, the student does visit the school occasionally to discuss progress and the teacher noted that the student found the regular LIL FM sessions beneficial. The other five interviews followed a pro-forma in which the teachers were asked about:

- teachers’ use of LIL FM with their students;
- students’ access to the sessions and attendance;
- students’ use of the resources on the Integral website;
- teachers’ views on LIL FM as a teaching and learning platform.

Teachers’ use of LIL FM with their students
LIL FM was brought to the attention of three of these teachers by the local Area Coordinator. Another teacher was aware of tuition opportunities through the FMSP and considered LOT, but with only two students decided LIL FM was the preferred option. One teacher explained that although her school offers Further Mathematics as a face-to-face course, one student couldn’t attend all the classes so used LIL FM for the modules he was missing. Another teacher explained that they offer AS level Further Mathematics to those students who want to take up Further Mathematics in Year 13, but they cannot provide timetable time; they offer LIL FM to the students if they want to take it up, else the students work on their own; she said three students were using LIL FM. Three teachers said that the LIL FM sessions were used to support the students as they were on a reduced timetable for
Further Mathematics; typically they had two hours a week with their teacher. The reduction in timetable time was due to both small student numbers and staffing difficulties. The students all wanted to study Further Mathematics having been advised it would enhance their application to university.

Students’ access to the sessions and attendance
Two teachers noted how this varies with individual students. Committed students attended all the sessions and although they felt the quality of presentation varied, they felt they got a lot out of the course. It should be noted that it is very likely that students’ views of the same presenter will vary amongst the students, and an individual student’s view of different presenters is also likely to vary, particularly depending on their own experiences of teaching and learning.

All teachers said they followed up absentees and were pleased FMSP kept them informed of non-attendees. One student was only using the recordings, and one student wasn’t following the LIL FM sessions at all despite encouragement from his parents to do so. One teacher noted that her students only occasionally missed a session and would watch the recording soon after. Her students were positive about the LIL FM sessions. One teacher commented that her LIL FM student liked to do things ‘his way’, but he did like the LIL FM sessions and the support they gave to his self-study. Two of the teachers noted that they watch the recordings to refresh their own knowledge to aid discussion of the topics with the students and for ideas on how to teach topics. One commented that he could find no facility to rewind a recording so that a particular point could be gone over again. However, the system used does have this facility, so may be LOPD tutors should give more detail of this facility to participants.

Students’ use of the resources on the Integral website
The teachers reported that all the students have access to the website and they encourage the students to use it. One teacher noted that it is mostly left to his students’ own initiative to do so whereas another noted how she guides students to appropriate activities which she also uses in class discussion and her students make relatively little independent use of Integral. The teachers said that students are generally positive about the resources and find them useful, particularly mentioning notes and examples and the multiple choice questions. Most of the students like these resources, some considerably so, although there are some students who haven’t used them.

Teachers’ views on LIL FM as a teaching and learning platform
Teachers reported that the students took readily to the virtual classroom, and reported no problems except for the occasional one with connection, but these were easily resolved. One student had suggested that YouTube might be a better platform! Teachers reported that students’ views varied but the vast majority were satisfied with the presentation of the sessions and their schedule. The teachers reported that their timetable time between sessions was used to prepare students for the next session and as well as reviewing and discussing any points of difficulty. One teacher noted that students did find the lectures hard, so support from the teacher was essential.
4.2.3 LIL FM Conclusions

These five teachers seem to be content that LIL FM is providing what they wanted for their students in a cost effective manner and that students are benefiting from following the course. Five teachers is a small sample but even so there is quite some variation in the reported views of how students are using LIL FM and the Integral resources. This variation in how LIL FM is currently being used should be taken into account when both developing LIL FM and promoting it to schools/colleges.
5. Impact of the Further Mathematics Support Programme

5.1 Registrations with the FMSP

The FMSP classifies schools and colleges that register with it as being up to Key Stage 4, up to Key Stage 5 and Key Stage 5 only, the latter largely relating to further education colleges.

As at February 2014, there were 1996 establishments registered as up to Key Stage 5, and 146 as Key Stage 5 only. The figure for the up to Key Stage 5 establishments indicates that all but about 50 of the state establishments in this category are now registered with the FMSP, whereas the Key Stage 5 only figure indicates about 30% of the further education colleges in England are registered. Many schools without sixth forms have also registered; these will largely be 11-16 schools. Registrations by these schools have increased by about 50% from 371 in June 2012 to 553 as at February 2014, the current figure representing more than half of the 11-16 schools in England.

A survey was planned as part of the Phase 4 evaluation, to assess the awareness of the services that the FMSP offers in a sample of establishments from each of the above categories. The survey was conducted online, with the questionnaire sent to a pro-rata sample of 500 establishments. However, the response was very poor, with only 34 completed questionnaires, 19 of which were from 11-16 schools.

However, as registration by 11-16 schools is relatively new in the development of the FMSP, responses from these schools to the five FMSP services they were asked about is shown in Table 5.1. There were only three responses available in the survey, these being the school uses the service, is considering using the service, or is not and doesn’t plan to.

Table 5.1 Take up of FMSP services in a sample of 11-16 schools

<table>
<thead>
<tr>
<th>FMSP service</th>
<th>use</th>
<th>consider</th>
<th>not use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrichment events in mathematics for Key Stage 4 students</td>
<td>7</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>CPD for teachers in enrichment and extension for Key Stage 4 students</td>
<td>7</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>The Year 10 Mathematics Challenge competition</td>
<td>9</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Support and free resources for the OCR Free Standing Mathematics Qualification</td>
<td>5</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Support and free resources for the AQA Level 2 Certificate in Further Mathematics.</td>
<td>4</td>
<td>9</td>
<td>6</td>
</tr>
</tbody>
</table>

A small sample such as this cannot be representative of all the 11-16 schools that have registered with the FMSP, but Table 5.1 does suggest there is a high degree of awareness and potential take up of the FMSP services available in this sector.
5.2 Development of Further Mathematics in schools and colleges

5.2.1 Classification of schools and colleges by take up of Further Mathematics

It is difficult to classify schools and colleges by the number of students who are entered for the A level Further Mathematics examination. This is due in part to the number of entrants being associated with the number of students studying A level subjects in the establishment, although this isn’t always the case. According to data derived from the DfE’s National Pupil Database (NPD) there were 70 state funded establishments with more than 20 entrants in A level Further Mathematics in 2012; of these about half of them were large colleges, many of them former sixth form colleges, and many were state grammar schools. Of the 10 establishments with over 40 entries, 8 were colleges. These establishments also had large entries for A level Mathematics. The correlation between numbers entered for A level Further Mathematics and numbers entered for A level Mathematics for all establishments, for 2012 was 0.885, which shows a very close relationship.

Table 5.2 shows an analysis of the number of entries from state establishments to A level Further Mathematics for the 10 years 2003 to 2012.

Table 5.2 Entries from state school and colleges in A level Further Mathematics 2003-2012

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 entries</td>
<td>1082</td>
<td>1101</td>
<td>1128</td>
<td>1232</td>
<td>1269</td>
<td>1293</td>
<td>1359</td>
<td>1503</td>
<td>1478</td>
<td>1601</td>
</tr>
<tr>
<td>1 to 5 entries</td>
<td>798</td>
<td>795</td>
<td>760</td>
<td>786</td>
<td>748</td>
<td>700</td>
<td>639</td>
<td>568</td>
<td>565</td>
<td>581</td>
</tr>
<tr>
<td>6 to 10 entries</td>
<td>316</td>
<td>287</td>
<td>273</td>
<td>230</td>
<td>217</td>
<td>184</td>
<td>177</td>
<td>136</td>
<td>124</td>
<td>119</td>
</tr>
<tr>
<td>11 to 20 entries</td>
<td>140</td>
<td>129</td>
<td>126</td>
<td>93</td>
<td>80</td>
<td>65</td>
<td>58</td>
<td>39</td>
<td>38</td>
<td>39</td>
</tr>
<tr>
<td>over 20 entries</td>
<td>70</td>
<td>56</td>
<td>55</td>
<td>44</td>
<td>36</td>
<td>25</td>
<td>16</td>
<td>8</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>total 1 or more entries</td>
<td>1324</td>
<td>1267</td>
<td>1214</td>
<td>1153</td>
<td>1081</td>
<td>974</td>
<td>890</td>
<td>751</td>
<td>738</td>
<td>746</td>
</tr>
<tr>
<td>total</td>
<td>2406</td>
<td>2368</td>
<td>2342</td>
<td>2385</td>
<td>2350</td>
<td>2267</td>
<td>2249</td>
<td>2254</td>
<td>2216</td>
<td>2347</td>
</tr>
</tbody>
</table>

The classification in Table 5.2 of 1 to 5 entries, 6 to 10 entries and so on is somewhat arbitrary but illustrates the growing number of students who take A level Further Mathematics. It is evident in Table 5.2 that there is a gradual increase in the number of entries year on year, whilst the number of establishments with no entries declined. Over these years, establishments will have been moving between the classifications and some will have offered Further Mathematics for the first time. All types of establishment appear in all classifications, including no entries.
5.2.2 Survey of Teachers

As part of the evaluation it was planned to interview a sample of teachers from establishments in the different categories. To make the selection for the sample the categories were refined and limited to the four years 2008/09 to 2011/12.

These categories were:

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of students taking Further Mathematics</th>
<th>Schools</th>
<th>Colleges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>More than 20</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>More than 10 and increasing year on year*</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>More than 10 in each of the 4 years</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>4</td>
<td>Increasing year on year **</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>At least 1 but less than 4</td>
<td>54</td>
<td>3</td>
</tr>
</tbody>
</table>

*Each of these five establishments had more than 20 students in 2011/12.

**This category included establishments with very low numbers in 2008/09 including some with no entries.

Teachers from establishments in each category were contacted and invited to either take part in an interview about their provision of Further Mathematics or to complete a survey. However, there were only 11 responses, despite repeated requests. Each interview or survey questionnaire covered the following questions:

- When did you start offering Further Mathematics /who teaches it / how is the teaching organised?
- How did you first come across the FMSP / have you met your Area Coordinator?
- Do you promote Further Mathematics as a post 16 option?
- Are there any barriers to the development of Further Mathematics at your school/college?
- What role do you see for the FMSP in developing Further Mathematics at your school/college?

These 11 responses differed quite considerably, and so are difficult to summarise. The responses are presented as case studies in Appendix F.

Conclusions

The 11 responses from schools/colleges in the different categories (Appendix F) indicate that establishments are quite different in their provision of Further Mathematics. In some establishments they attract viable numbers of students year on year, whereas in others the take up is often only by a few students and in some years none. The take up doesn’t appear to be particularly related to the type or size of the establishment, but it does appear as in 5.2.1 above, that establishments with large numbers of students studying A level subjects are likely to have a relatively large take up of Further Mathematics.

However, the type of school/college doesn’t appear to always relate to the number of students taking Further Mathematics and there are other factors involved. One of these factors is the availability of teachers and management constraints on timetable time; some Senior Management Groups allow small numbers of students to be deemed a viable group whereas others do not. There
are a variety of models in use for teaching Further Mathematics to meet teacher availability and time available, depending on the circumstances of individual establishments.

Another factor is the aspirations of students in Key Stage 4 and whether they have the desire, and ability to take Further Mathematics, and how this is perceived by teachers. Even for more able students who could take Further Mathematics, there are barriers to take up such as it is often the fourth or fifth A level so is dropped if not essential for Higher Education; the work load for students is too high. However, many teachers believe students who have studied Further Mathematics get a better result in the main A level through doing so.

Most of the schools and colleges in the case studies are now teaching their Further Mathematics course themselves but still value the support of the FMSP. Professional development provided by the FMSP is found to be very good, and support from local ACs is generally valued. Teachers like being kept in touch and informed of FMSP events, even if they are unable to attend. In these establishments enrichment opportunities for students varied considerably although team competitions are popular.

The impact of taking Further Mathematics on results in the main A level in Mathematics is investigated further in Section 5.2.3.

5.2.3 Data analysis of the impact of introducing Further Mathematics to a school or college curriculum

Data were obtained from the DfE’s National Pupil Database (NPD) on entries to A level Mathematics and A level Further Mathematics and the candidates’ grades following the examination for the ten years 2003 to 2012 inclusive. These data were for the completion of the A2 part of the course; AS level data were not considered. The data analysis was restricted to students in state funded schools and colleges.

The change in entries over this ten year period to Further Mathematics is shown in Table 5.1 above; as at 2012 the Table indicates there were 1324 establishments with at least one entry, and 1082 establishments with no entries.

The methodology of the analysis here focussed on the year in which the first entries to a Further Mathematics examination were made and subsequent developments in student take up and achievement. It is likely that students in most establishments would have studied Further Mathematics for two years before taking the examination.

Achievement was measured in terms of ‘UCAS points’ by converting the candidates’ grades in the NPD into ‘UCAS points’ where the minimum pass grade E is worth 40 points and each subsequent grade attracts a further 20 points; or the difference between consecutive grades is 20 ‘UCAS points’.

The number of establishments that had their first entry to Further Mathematics in a particular year, is shown in Table 5.3. For example, in 2007, there were 128 establishments with no entries in the period 2003 to 2006, but had at least one entry in 2007.

Table 5.3 Year of first entries in Further Mathematics

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishments</td>
<td>110</td>
<td>148</td>
<td>128</td>
<td>122</td>
<td>136</td>
<td>92</td>
</tr>
</tbody>
</table>
Year of first entry was taken as 2005 in order to investigate the effect on take up and achievement in A level Mathematics from 2003 and onwards, with 2003 providing a baseline year. The measure of student achievement in each establishment was taken to be the weighted mean of the ‘UCAS points’ calculated from the NPD data for both A level Mathematics and Further Mathematics.

The development of the take up in Further Mathematics subsequent to its introduction was considered in two ways. Firstly, those establishments which in a subsequent year up to 2012 had at least one year in which there were ten or more entries, and secondly, those establishments which in a subsequent year up to 2012 had at least one year in which there were four or more entries but fewer than ten. The figure ten was chosen to be in accord with establishments where student entries in Further Mathematics were likely to be sustained at this sort of number and possibly grow. The figure four was chosen to be in accord with establishments where student entries in Further Mathematics might become viable. The mean values for student entries and their achievement together with the standard deviation are shown in Tables 5.4 and 5.5. Due to size of these Tables they are appended at Appendix G.

Table 5.3 shows, for example, that for the 14 establishments that had first entries in A level Further Mathematics in 2005, the mean cohort size for Further Mathematics was 2.4 and by 2012 this had become 9.4; the corresponding cohort sizes for A level Mathematics are 22.7 and 46.8.

There are several points to note about these two Tables. Firstly only those establishments for which there was at least one entry into A level Mathematics every year for the full ten years, were included in the calculation of the mean and standard deviation. In each year, many other establishments were identified as meeting the criterion, but had an incomplete record; this was due to various reasons including establishments changing their DfE ID codes through mergers, or the creation of new academies, or in some cases the local authority being divided into two and thus schools and colleges in their regions being given new codes. The standard deviations also indicate considerable variation about the mean, and this could be seen in the detailed spreadsheets showing all the establishments from which Tables 5.4 and 5.5 were derived. It should also be noted that the establishments identified in each year are unique; an establishment cannot appear in more than one year.

The data in Table 5.4 show that on average there is a general increase in the number of students entering for A level Mathematics (AM students) and their mean achievement. Similarly, after Further Mathematics has been introduced, student numbers (FM students) and their mean achievement across all the establishments in the introductory year, tend to increase. It is not consistent year on year, and the detailed spreadsheets showed considerable variation in individual establishments, but there is evidence here that in general introducing Further Mathematics is associated with growing student numbers and achievement in both A level Mathematics and Further Mathematics.

Table 5.5 also contains data for those establishments who did not introduce Further Mathematics in any of the years considered. There were 112 such establishments.
The first thing to note in Table 5.5, is that the number of establishments involved in each introductory year is considerably higher than that in Table 5.4. This is not surprising given the lower criterion for inclusion, but the two Tables taken together show that a considerable number of establishments introduced Further Mathematics between 2005 and 2012 inclusive. The data in Table 5.5 show similar trends in student numbers and achievements to those in Table 5.4. Again it is not consistent year on year, and there is wide variation amongst individual establishments, with some having no Further Mathematics students in some years, but in general there is a positive growth in numbers and achievement associated with introducing Further Mathematics. This is borne out further by the data for A level Mathematics in those establishments where there was no Further Mathematics; on average these 112 establishments show some growth, but rather less than in establishments that introduced Further Mathematics.

Tables 5.6 and 5.7 (Appendix G) are an alternative way of presenting these data. They show the change in student numbers and achievement between the year of first entries in Further Mathematics and 2012, with achievement translated as a fraction of a grade.

Some comparisons with the 2012 data actually show a reduction in numbers or achievement, but these tend to be small and more so a comparison with the 2011 data in most cases shows a positive increase. There is also evidence that the longer Further Mathematics has been included in the curriculum, the bigger is the associated effect on A level Mathematics student numbers and achievement. This seems quite reasonable as it is likely that teachers will have been on professional development courses and/or generally increased in confidence in their teaching with each new intake of students. There is also a belief held by some teachers that a student who takes A level Mathematics is likely to boost his/her grade in A level Mathematics (Section 5.2.2), although having Further Mathematics on the curriculum is not felt by some teachers to influence students who only study A level Mathematics.

5.2.4 Impact of the FMSP from the perspective of the Area Coordinators

The FMSP currently has 30 Area Coordinators, each responsible for an area within the nine regions of England. Each of the Area Coordinators was sent a survey questionnaire, the aim of which was to attempt to identify those aspects of the FMSP which have contributed most to its impact.

For this survey, the services that the FMSP offers were classified under three broad headings:


The services offered under heading (1) and (2) were delineated and the ACs were asked to put them in order of having the most impact, as they saw it. Similarly with aspects of the organisational structure of the FMSP. The ACs were invited to make any comments or observations on their choices if they wished to. All the ACs responded to the survey, and most made some qualifying comments.

The results are shown in Tables 5.8, 5.9 and 5.10. The totals do not sum to 30 as for some services and aspects of organisation, ACs put some of the options as equal in impact so these were not included in the totals and in some cases just left blank. It is notable that the category ‘other’ got very little response, suggesting all the main services had been included in the survey.
The FMSP services were as follows:

1. ** Provision for teachers

   (a) Advice on delivering Further Mathematics
   
   (b) CPD for teachers in A level Mathematics – online and/or face-to-face
   
   (c) CPD for teachers in A level Further Mathematics – online and/or face-to-face
   
   (d) CPD for teachers in extension and enrichment work for A level students, including problem-solving, and support for the Sixth Term (STEP) and Advanced Extension Award (AEA) examinations
   
   (e) CPD for teachers in extension and enrichment work with students at Key Stage 4 preparing for GCSE
   
   (f) Regionally based knowledge networks and/or other support groups
   
   (g) Other – please specify

<table>
<thead>
<tr>
<th>Table 5.8 Provision for teachers</th>
<th>Number of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rank 1</td>
</tr>
<tr>
<td>a</td>
<td>8</td>
</tr>
<tr>
<td>b</td>
<td>7</td>
</tr>
<tr>
<td>c</td>
<td>10</td>
</tr>
<tr>
<td>d</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>3</td>
</tr>
<tr>
<td>g</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
</tr>
</tbody>
</table>

The views of the ACs did vary quite widely, but where there was some consensus, the results have been highlighted. For provision for teachers options (a) and (c) stand out as having the most impact and options (d) and (f) the least. It is likely that the response (d) is low as the STEP/AEA cohort of students is only about 10% of the Further Mathematics cohort and thus unlikely to be considered high impact when compared to the other items in the list.

2. ** Provision for students

   (a) Tuition in Further Mathematics modules – online and/or face-to-face
       
       Live Interactive Lectures (LIL) / Live Online Tuition (LOT)
   
   (b) Revision events in A level Mathematics – online and/or face-to-face
   
   (c) Revision events in A level Further Mathematics – online and/or face-to-face
   
   (d) Enrichment events in mathematics for Key Stage 4 students
   
   (e) Enrichment events in mathematics for Key Stage 5 students
   
   (f) The Senior Team Mathematics Challenge (aimed at Key Stage 5 students)
   
   (g) The Year 10 Team Mathematics Competition
   
   (h) Other – please specify
Table 5.9 Provision for students

<table>
<thead>
<tr>
<th></th>
<th>rank 1</th>
<th>rank 2</th>
<th>rank 3</th>
<th>rank 4</th>
<th>rank 5</th>
<th>rank 6</th>
<th>rank 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>14</td>
<td>7</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>11</td>
<td>9</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>g</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>h</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>26</td>
<td>26</td>
<td>26</td>
<td>22</td>
<td>23</td>
<td>6</td>
</tr>
</tbody>
</table>

Again there is a quite wide variation in the views of the ACs, but where there is some consensus the results have again been highlighted. Options (a) and (d) stand out as having the most impact with options (c) and (f) having the least.

3. Organisational structure of the FMSP

(a) The Central Team
(b) Administrative support from FMSP Office, Trowbridge
(c) Regionally based Area Coordinators and Associates
(d) Regionally based management and support for Area Coordinators and Associates
(e) Input from the DfE (as funders of the FMSP)
(f) MEI (as managers of the FMSP)
(g) Other – please specify

Table 5.10 Organisational structure

<table>
<thead>
<tr>
<th></th>
<th>rank 1</th>
<th>rank 2</th>
<th>rank 3</th>
<th>rank 4</th>
<th>rank 5</th>
<th>rank 6</th>
<th>rank 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>b</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c</td>
<td>16</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>d</td>
<td>0</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>g</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>26</td>
<td>24</td>
<td>25</td>
<td>22</td>
<td>23</td>
<td>3</td>
</tr>
</tbody>
</table>

For the organisational structure of the FMSP option (c) really stands out as having the most impact and options (e) and (f) the least.
All the ACs did note how difficult it was to decide an order, so the results do need to be interpreted with caution. This is illustrated by a quote from one of the ACs, given below.

The same survey questionnaire was also sent to each of their Line Managers, to assess their views on the impact of the FMSP; 12 responses were received. Some other line Managers did respond but explained that they felt unable to contribute to the survey and it was best left to the ACs who worked closely with their schools and colleges. Of those who did respond as desired, several put options equal or left them blank and so little can be discerned from the results and they are not included here.

Quote from one of the ACs

I have found it very difficult to unpick the relative importance of the different strands of activity. Although I have tried my best to weigh up the level of impact on each individual teacher against the number of teachers experiencing the impact and make some sort of decision on that basis, I feel the last couple of points on my list have not had that much less impact than the first few. One of the things I feel very strongly is that the success of the FMSP is related to the whole package of support that we offer. Any one of resources, advice and CPD in isolation would have much less impact than it does as part of a package of support. Teachers feel confident to extend their teaching and to advocate developments within their schools because they have someone who can advise them backed up by the CPD and resources to support their day-to-day teaching and that of their colleagues. Obviously, the other element that is vital to the continued success of the programme is the quality of the advice, CPD and resources which ultimately comes back to the expertise of the people involved. I count myself as one of the least experienced and knowledgeable ACs but I am part of a team of people with a wealth of experience and knowledge and a willingness to support one another which means that teachers get the best possible support.

Interviews with Area Coordinators on the impact of the FMSP

Further to the survey, interviews took place with 15 Area Coordinators (ACs), on what they considered to be the biggest impact of the FMSP and what factors have brought this about. Most said that this was a difficult question to answer as the FMSP does so much and relates to schools and colleges in a variety of ways. However, the most frequent answer was the increase in the number of students now studying Further Mathematics. This and other responses are delineated below.

1. Increase in student numbers taking both A level and AS level Mathematics and Further Mathematics.
2. Providing tuition and support for all students who wish to study Further Mathematics.
3. Professional development for teachers; this was thought to be particularly important in enabling schools and colleges to take the teaching of Further Mathematics ‘in-house’ and thus become sustainable.
4. Engaging with teachers, through ‘phone and email contact and also face-to-face events; helping to facilitate teacher networks and forums thus creating a local community of teacher practitioners; enthusing and motivating teachers to support each other.
5. Support for mathematics across a school, but particularly from Year 10 onwards; changing attitudes of students and teachers towards a more positive view of mathematics through a variety of enrichment opportunities.
The ACs found it difficult to separate the impact of the FMSP from the factors that had brought it about. Several of the points in 1 to 5 above were reiterated by the ACs during the interviews. One common theme was that the ACs work locally; they know the schools and colleges in their area and the teachers in the mathematics departments in these establishments know them, but to varying degrees. One strength the ACs believe they have is that they can respond flexibly and try to meet the needs of individual establishments noting that these can vary widely. In particular the size of sixth forms and the number of students taking Mathematics and Further Mathematics at A level varies widely as does the number of suitably qualified and experienced teachers to teach mathematics at this level. It was noted that some establishments are very involved with the FMSP and what it offers, some rather less involved and some not at all. All ACs reported that they strive to maintain links with all establishments in their area and to create and develop them with an establishment that is reluctant to become involved. Some ACs particularly highlighted the increasing involvement of 11-16 schools in the activities of the FMSP, where they have schools with this age range of students in their area. It was noted that teachers and students in these schools are developing a better understanding of what post-16 mathematics has to offer and a better awareness of Further Mathematics in particular helping to remove the myth that it is hard subject.

On establishing links, most of the ACs said that they had met a Head of Department, Key Stage 5 Coordinator or Head of Sixth Form from their local establishments, or at least there had been contact of some form. It was noted by many that once contact is made, often through meeting at an event, or a personal visit to an establishment, and what the FMSP has to offer is explained, the relationship usually develops positively. Some ACs have found schools where their priorities focus on improving results at GCSE, and it is difficult to persuade such schools that the FMSP could have a role in that as well as encouraging students to pursue mathematics post-16. All the ACs keep establishments in their area informed of forthcoming events and opportunities for teacher professional development, and this is generally appreciated by teachers; they like to be informed even if they are unable to attend.

All the ACs highlighted that creating opportunities for teachers from different establishments to meet each other, through professional development courses or at events, had a positive effect in encouraging teachers to work together and share resources. It was noted that many local authorities now have no officer in charge of liaison between establishments and that for mathematics, the FMSP is now fulfilling this important role to some extent; local authorities would have had a much wider brief than the FMSP, through covering primary schools and the whole of the secondary sector. Many of the ACs felt that the FMSP has developed a very strong reputation for high quality events such that now when such events go on offer they fill up quickly. FMSP events and services are clearly valued by teachers.

The ACs also noted how they work together and how having a Regional Manager who oversees a small group of them, enables them to meet regularly and discuss any matters and issues. This was thought to be very beneficial, as it helped to keep up to date with developments in the FMSP and future plans as well. It was noted that a member of the FMSP Central Team is often present at these meetings, so the Central Team get first hand feedback as well. The ACs also highlighted the mutual support they have through the ACs online forum and this was thought to be very valuable; they are able to stay in touch with their colleagues and all that is going on within FMSP, and take and adapt any ideas for implementation in the establishments in their own area.
It was noted that within the 30 current ACs there is a great range of backgrounds and experience, all of which can be shared. Many of the ACs noted the passion that they collectively and the Central Team have for mathematics and together with their commitment to mathematics education this was felt to be a vital factor in the success and positive impact of the FMSP.

Many of the ACs emphasised the importance of the range of professional development opportunities the FMSP provides. It was noted that feedback from these events is very positive and teachers take away a range of teaching strategies and resources for use in their classrooms. The ACs believe that this increases teacher confidence, particularly when teaching a topic for the first time, and that this in turn leads to a positive response from students. It was noted that teachers through these events, and others, develop their own appreciation of the importance of post-16 Advanced Mathematics and that this can feedback to students, particularly pre-16 students in schools. The result is a raising of the profile of mathematics in establishments and changing students’ attitudes towards it; it is believed this is very much related to the increase in number of students taking both A and AS level Mathematics and Further Mathematics as students come to realise the value of an advanced level qualification in mathematics. This is further enhanced for students who have had the opportunity to take part in an enrichment event. Many ACs made the comment that feedback from teachers was along the lines of ‘the best CPD I’ve ever done’, and that teachers now expect the FMSP to provide quality events and are confident that this will be the case.

5.2.5 Development of Further Mathematics in the Priority Schools

The definition of priority schools is given in appendix A. A list of priority schools was first agreed between the DfE and the FMSP in 2011/12, when ACs started approaching them to encourage the development of A level Mathematics and Further Mathematics. This aspect of the role of the ACs has continued. The number of priority schools in different parts of the country does vary, so some ACs have many such schools to attempt to engage with whilst others have relatively few. To gain two perspectives on the priority schools, the interviews with the ACs above were extended to seek feedback on their progress with engaging the schools with the FMSP, and ACs were also invited to nominate teacher contacts they had developed in the schools, who might be willing to do an interview.

Interviews with Area Coordinators on Priority Schools

All the ACs interviewed have had similar experiences with the priority schools in their area. For some schools once contact has been made with a teacher in the school, the relationship has developed. Often the school started with one or two students studying AS level Further Mathematics with FMSP support but student numbers have grown while staff have undertaken professional development, so that Further Mathematics at both AS and A level has become well established. Other priority schools still have small numbers of students, but continue to offer Further Mathematics to interested students and explain how they might be taught. All ACs noted they still have some priority schools and colleges who make no response to becoming involved with the FMSP and thus possibly offering Further Mathematics.

The need to make a personal contact was emphasised by all the ACs; most noted it is difficult, but essential, to find the right member of staff in a mathematics department, with whom to establish a relationship. It was noted that emails or ‘phone calls generally do not lead to any response. ACs try to involve these schools through invitations to events, usually free of charge, so that they might
meet an appropriate teacher and initiate a relationship. Many ACs noted that if they can then arrange a visit to the school or college and show teachers the resources that the FMSP can offer and also the various support and tuition models that could be customised to the establishments’ needs, then the offer of Further Mathematics to students will often start. It was also noted that if such teachers are invited to come along to a local networking event and take it up, then they can benefit from meeting teachers from schools or colleges where Further Mathematics is, or is becoming, established and so can share in their experience.

Some ACs found that in some schools in which the sixth form is small, and possibly lacking in students who are academically very able, the schools see no point in offering Further Mathematics. Their priorities usually lie elsewhere, particularly in trying to improve GCSE results, or generally responding to an Ofsted report. In this respect, some ACs noted the importance of trying to persuade a school to come to an enrichment event for Key Stage 4 students so that students might be enthused about mathematics and also become more aware of post-16 options; as one AC put it, there is a need to widen the horizons of the Key Stage 4 students in these schools.

It was generally felt amongst the ACs that there are three essential factors to initiating the offer of Further Mathematics. These three factors are:

- there must be at least one student who wants to do it; this might come from raising awareness in Key Stage 4 or in the sixth form itself;
- there must be at least one member of staff who wants the department to offer Further Mathematics, either through tuition provided by the FMSP, or teaching it within the department, or as is often the case, a mix of both;
- there must be management support.

One AC noted how in one school the Head of Department had vetoed the introduction of Further Mathematics saying it wasn’t relevant to their students. Several ACs highlighted the importance of the FMSP’s Access to Further Mathematics events in this regard, and helping schools and colleges to understand how studying Further Mathematics could be beneficial to their students and their subsequent careers. One AC highlighted the need for supporting inexperienced but keen teachers in their teaching, through helping them with particular difficulties in the mathematics itself, suggesting teaching strategies or advising on professional development opportunities.

Some ACs highlighted how the number of priority schools varied between areas, and in some of these areas where there are still state grammar schools, this can have an effect as the more able have opportunity to transfer to a grammar school at age 16. It was noted that some students prefer to stay at ‘their’ school and the school will usually provide tuition for such students somehow, often in conjunction with the FMSP. In one example of this, the AC said the student concerned had gone on to obtain a first class degree in mathematics, noting that catering for an individual student’s needs is important. It was also noted that in some of the grammar schools only the most able are allowed to take Further Mathematics, and thus opportunity is denied to some who could benefit from taking it.

---

7 Access to Further Mathematics events were initiated by the FMSP in 2011 with the aim of encouraging the introduction of Further Mathematics in schools and colleges that don’t currently offer it and to help improve and develop provision in those that have recently introduced Further Mathematics. See Section 6.2.5
Another AC noted the difficulties raised by a school being a member of an academy chain. It was noted that that decisions about initiatives in mathematics and professional development for teachers may not be made by individual schools, but might have to come through management of the chain. Some schools have said because of the chain, they have no need for involvement with the FMSP. Clearly this is an area that the FMSP should investigate.

It was noted by many of the ACs that bringing a priority school into engaging with the FMSP and introducing Further Mathematics to their curriculum was a slow, gradual process. It may take several years, and that for many schools, once initiated, their student numbers are likely to stay less than 10 and in some years there may not be any students. The ACs noted the importance of staying in touch with such schools, and some schools themselves had asked to be kept informed of events and opportunities.

**Interviews with teachers from Priority Schools**

The ACs were asked to supply the evaluator with information on the development of Further Mathematics and engagement with the FMSP of the priority schools in their area. From these the evaluator selected ten establishments, and through the AC concerned, made arrangements for a telephone interview with their teacher contact. The ten establishments were all comprehensive schools, with sixth forms, from various parts of the country.

The teachers were interviewed using a pro-forma which covered the following questions:

- How long has your school been involved with the FMSP?
- Why did you decide to become involved with the FMSP?
- How is the teaching of Further Mathematics organised in your establishment?
- What support have you received from the FMSP; how effective has this been?
- How do you see your mathematics department developing; what are the priorities?
- What further support are you looking for from the FMSP?

**How long has your school been involved with the FMSP?**

**Why did you decide to become involved with the FMSP?**

Many teachers couldn’t actually recollect their first contact, but it varied from in the current year to several years ago. The nature of the first contact varied considerably. Two teachers explained that they had responded to an email from the AC and wanted to know what the FMSP had to offer. Another noted her school had been registered for several years and had been making use of the **Integral** resources; the teacher knew the AC through the local authority before she took up the AC role. One teacher said that the school was registered by the previous Head of Department, and she wanted Further Mathematics to develop in the school. Another teacher noted that her school was already registered, but she wanted to develop A level provision and so contacted her AC. Another Head of Department was concerned that he was losing post-16 students because the school didn’t offer Further Mathematics; the AC had initiated contact with the school, so they asked for help and advice. Another Head of Department noted he had tried for several years to introduce Further Mathematics, but the senior management wouldn’t allow it as numbers were too small, but eventually they relented. He made contact with the FMSP through the local authority. Another teacher explained how he went to a conference where the FMSP made a presentation and he met the AC through the ACs’ university post; it developed from there.
How is the teaching of Further Mathematics organised in your establishment?

Each school was fairly unique in its development of Further Mathematics and its current provision, all of which is to relatively small numbers of students; mostly less than 10. One teacher explained how they started with just one student, who studied independently, and currently have students supported through the FMSP via LOT; it was said some of these are taking Further Mathematics with a view to improving their main A level grade. In this school Further Mathematics will be timetabled with a member of staff from next year. Another teacher explained how they started with FMSP support through LIL and some in-house support, but now she teaches the FP1 module, whilst they continue to use LIL for applications modules. Her students take the AS course ‘by invitation’ over two years.

Another school uses LIL but there is no timetabled support, but the teacher gives support anyway. He refreshes his own knowledge using LIL recordings. He hopes some students will continue to the full A level next year. In another school, the suitability of students to take Further Mathematics is decided in consultation with the Head of Sixth Form, and those who they thought could benefit attend face-to-face tuition sessions with an FMSP tutor. In another school, teaching was initially done by the AC, but the teaching is now ‘back-in-house’ and timetabled as the school has employed some more specialist mathematics teachers, whilst also encouraging inexperienced teachers to become involved with the teaching of Further Mathematics.

Another teacher explained how she had some students who had taken additional mathematics in Year 11 and wanted to continue with Further Mathematics. This was achieved by a ‘complicated’ mix of LOT and LIL with support from both the teacher herself and the AC. She noted some students are continuing to the full A level. Another teacher explained that he and some colleagues are graduate mathematicians and have taught themselves the Further Mathematics topics, and started teaching the AS level themselves last year with timetabled provision. Prior to that, their first student had attended tuition sessions at the local university provided by the FMSP. The department has secured confirmation from senior management that students can continue to the full A level next year if they wish to.

Another teacher explained how she had started with one student, who used LIL with the AC making the arrangements and providing some professional development including the teachers using the LIL sessions; she and a colleague are now teaching the AS course ‘in house’. Another teacher explained that although they have a large cohort of around 60 students, who start the main A level Mathematics course, they have only this year introduced Further Mathematics. They are teaching it themselves on a full timetable and expect the students to continue to the full A level. Another teacher explained how they decide year by year how to offer Further Mathematics; currently one teacher is teaching AS Further Mathematics on a full timetable; previously AS Further Mathematics was taught over two years. They have had students take the full A level with support for the A2 modules through the FMSP LOT provision.

What support have you received from the FMSP; how effective has this been?

All the teachers interviewed indicated how appreciative they are of all the advice and support they received from their AC in setting up Further Mathematics in their school, and that this is on-going. Most have been involved in professional development of some sort including customised individual support, attending LIL sessions, following a course of LOPD sessions or face-to-face events and one teacher had taken the TFM course; all described as good. In one school two teachers had taken the
TAM course, which they found to be very good. Other schools are considering sending staff on these courses but noted the time constraints and the commitment involved. Some teachers have become involved in 16-19 teacher support networks facilitated by the FMSP. However, one teacher noted that a tight staffing budget has prevented the take up of professional development opportunities. One teacher described how his AC gives direct support to his students, both for Key Stage 4 students, gifted and talented students and Further Mathematicians. Many of the ACs have been into school to talk to Key Stage 4 students about post-16 opportunities in mathematics and what it can lead to career wise and have also given taster lessons.

Most schools too have been involved in enrichment events, particularly for Key Stage 4 students, although only some have been involved in the enrichment and enhancement professional development that the FMSP offered. Some considered it, and may attend this year. However, one teacher who had taken the course has introduced a problem solving approach into his department, and noted the positive response of the students, and how they are learning resilience and how to solve problems. Most schools enter a team for both the Senior Team and Year 10 Mathematics Competition, although one teacher reluctantly advised there was no one available to currently organise it for his students. The students who take part were said to enjoy it. Some schools also do the paper based UKMT challenges with their students. One teacher explained how he believes enrichment is preferable to acceleration for his students, and provides the Key Stage 4 students with many enrichment opportunities, including taking them to events and workshops and speakers visiting the school. One teacher explained that although much as he wants to offer his students enrichment experiences, as a 14-18 school they just don’t have the time as the focus is on achievement at GCSE.

The teachers generally make their A level students aware of the revision opportunities the FMSP provides, although take up isn’t usually monitored. Some schools put on their own revision sessions which students seem to prefer.

How do you see your mathematics department developing; what are the priorities?

Most of these teachers are positive about developing their departments so that more students continue into advanced study of mathematics post-16. Many made reference to their current Year 10 and 11 students and they are encouraged by the numbers indicating they are likely to take at least A level mathematics. This underlined the importance of making this age of students aware of possibilities and motivating their interest and enthusiasm for the subject. However, in some schools they thought that growth in numbers was unlikely and they see provision for Further Mathematics staying as it is for the foreseeable future whilst they focus on encouraging more to take A level Mathematics and enabling them to do so, through improving performance at GCSE. One teacher commented that his AC has helped to boost the numbers achieving grades A* and A at GCSE.

Several teachers noted that the number of students who drop out between AS level Mathematics and the second year of the full A level is diminishing, and that students are encouraged to continue. Several noticed that through professional development staff are becoming more confident to teach at advanced level, and they want the FMSP to keep providing such opportunities. One teacher noted that his school is now achieving the best A level results in his town and he wants to develop the capacity to maintain standards across all the A level teaching of mathematics.
One teacher described the support through LIL as ‘great’ and the Integral resources as ‘brilliant’; the school only have limited resources staff wise but he is hopeful that his two current students will be successful and so convince the senior management that Further Mathematics is worth developing in the school. One teacher noted that although students at her school can apply to local grammar schools for post-16 study some choose to stay, and she noted these students are enjoying taking Further Mathematics and she is sure they are benefitting from doing so.

Some want to involve more of the teaching staff in delivering Further Mathematics and will support them in taking up professional development opportunities. The need for some continuity should staff leave a school was recognised.

Some concern was expressed about the future of A level and the change from a modular to a linear system, and the effect this might have on student take up and the flexibility with which their schools can currently offer Further Mathematics.

What further support are you looking for from the FMSP?
The teachers interviewed were all very grateful for the continued support of their AC; using phrases such as “she is an invaluable source of information”, “always responsive and there for us” and “it is huge bonus knowing he is there”. They want such support to continue and for the ACs to be responsive and be able to advise on whatever issues might arise. The ability and the flexibility of the ACs to do this, is clearly valued. Others made more general comments such as “the FMSP provides a really valuable service” and “the FMSP is very, very good”. And “we would struggle without the FMSP”.

Some commented that they wished they had the time in their department to take more advantage of the opportunities the FMSP provides; but they want to stay in touch with their AC, be informed of what is on offer and to avail themselves of the opportunities when they can.

5.2.6 The FMSP and Teaching Schools and Academy Chains

According to the National College for Teaching and Leadership, Teaching Schools are outstanding schools that work with others to provide high-quality training and development to new and experienced school staff. They are part of the government’s plan to give schools a central role in raising standards by developing a self-improving and sustainable school-led system. Teaching Schools must have an outstanding rating from Ofsted, show excellent leadership and have formed successful partnerships. Partnerships can be with strategic partners and/or Teaching School alliances.

Strategic partners are other schools who wish to work with the Teaching School in their role. Teaching School alliances include Teaching Schools working with universities, local authorities, academy chains and private sector organisations. Teaching Schools are expected to offer a range of professional development opportunities for teachers, and strategic and alliance partners are likely to be involved in delivering such opportunities.

The FMSP supplied the evaluator with the names of contacts at schools that are registered with the FMSP and are also Teaching Schools. The evaluator selected six of these schools, four 11-18 schools and two 11-16 schools. The evaluator requested an interview with the FMSP teacher contacts, via the local AC, with a view to assessing the role of the mathematics department within the Teaching School responsibilities, and in particular what scope there was for involvement of the FMSP.
The four 11-18 schools all offer A level Mathematics and Further Mathematics with varying degrees of take up by students but all make use of several of the FMSP services and staff and students have attended FMSP events.

One teacher, a Head of Department, advised that his department had little involvement in the Teaching School role as it was mainly generic in his school, supporting teaching in general and leadership; it wasn’t subject based. He did however mention a partnership with another school and local university where there was input from the local FMSP AC on mathematics teaching. He was also hoping to develop networking meetings to discuss teaching and learning in mathematics with other local teachers, in which the FMSP could be involved.

Another Head of Department explained that her department was working with four other partnership schools in the area, and there had already been some sessions where the local FMSP AC had been involved, including delivering a session on use of graphics calculators in class and another on developing students’ problem solving skills. She noted she intended to widen the network to include more schools. She thought the FMSP, through the AC had an important role to play. She said, ‘we can’t really do without the FMSP and its brilliant resources, and the advice it has to offer’.

She saw a key role for the AC in the mathematics community she was hoping to develop in her area.

Another teacher talked about an initiative that was coming from the NCETM (National Centre for Excellence in Teaching Mathematics), called MESH (Mathematics Education Strategic Hubs), which is in the early days of development. She noted that Teaching Schools had an important part to play in the development of a MESH in their area, and she noted that in her area the FMSP AC is already involved in delivering some professional development sessions, and she will be involved in planning future MESH activities. The local university will also be involved within the partnership.

In the fourth 11-18 school, the Head of Department, focused more on developing the mathematical skills in younger students, and was forming partnerships with feeder primary schools. She had organised a ‘challenge day’ for students from Years 5 and 6, which she said was very successful. One of her principal aims was to increase the confidence of the primary school teachers to teach mathematics to these year groups. However, she went on to say that since her school had achieved Teaching School status, that she had had considerable involvement with the local AC. In her own school, she too was focusing on younger students in Key Stage 3, and was looking to the FMSP to provide some enrichment activities that would inspire this age of student; she noted in the past how they often become disillusioned as they approach GCSE. There was potential for this to expand to include other schools and older students.

One of the teachers from an 11-16 school had taken part in the extension and enrichment professional development (Section 3.4). She had tried out some of the activities with her students and shared them with her colleagues and she noted that the problem solving activity approach had been positively received by both her colleagues and the students. She wanted mathematics teaching in her school to develop this way and hoped that through being a Teaching School they could influence other schools. She noted in particular the opportunity to share resources and discuss their use. The evaluator conducted a follow up interview with the Head of Department from this school. She had been involved in the Further Mathematics Network in her area, as a member of the management committee, so was familiar with how the FMSP worked, but noted that the school had had little involvement until recently. She noted that her school is involved in Initial Teacher Training,
and will be making use of the FMSP website resources and those from the extension and enrichment events. She saw a possible role for the FMSP in supporting her trainee teachers who will be working up to Key Stage 4, and in advising on post-16 opportunities.

In the other 11-16 school, a girls’ school, the teacher said he knew the AC well; he had met the AC through involvement in the Year 10 Mathematics Competition. He noted the school offers additional mathematics and that they make use of the OCR resources provided by the FMSP. No-one from the school had been able to attend the extension and enrichment professional development event, but he was interested in this approach. He noted that in his school there is parental pressure for their daughters to be entered early for GCSE, but he is resisting this and arguing the case for extension and enrichment as a better preparation for A level. He intends to develop this with support from the AC. From the Teaching School perspective, he wanted younger students to develop problem solving skills as opposed to being shown techniques and ‘being told how to do it’.

The school is currently working in partnership with two primary schools to develop an investigative approach focusing on breadth in mathematics rather than depth. He hopes this will expand to other primary schools and he highlighted how the AC is always willing with help and advice in developing his aspirations noting that no advice is available from his local authority. He hoped that the problem solving approach would develop throughout his school, and he hopes it will continue at A level, noting his belief that mathematics should be taught in an integrated way to all students.

**Conclusion from these interviews**

These six schools are quite contrasting in how they are developing their Teaching School roles. Similarly contrasting is how the FMSP might help in the development of mathematics in that role. It is clear that all are keen for the FMSP to be involved, through the local AC both in giving advice and taking an active part in activities and developments. It is notable too that the age range of students mentioned for the extension and enrichment approach stretches from primary age students to post-16. There is clearly a lot of potential for the FMSP to become involved with Teaching Schools across England and also in the MESH’s as they start to develop.

**Academy Chains**

The FMSP supplied the evaluator with the names of contacts at schools that are registered with the FMSP and are also part of an academy chain. The contacts were again approached via the AC who knew them, but there was only one response. The teacher was from an 11-18 school that has recently introduced Further Mathematics and now has three students who are taking the AS level course over two years, making use of FMSP LIL with his support. He noted the help of the AC in setting this up, and also the professional development opportunities she had given access to; one teacher had been on the TAM course (Section 6.2.1). He hopes A level Mathematics and Further Mathematics will develop in his school, and he is hopeful in that his Key Stage 4 students have been involved in enrichment events and are showing interest in pursuing mathematics post-16. He again emphasised how he valued the input from the AC in developing these opportunities.

As far as the academy chain is concerned, this teacher said there is a mathematics coalition in which the Heads of Department meet and there is some co-working. He noted that although there are about 40 schools in the chain, few have sixth forms. He has looked for partnership support at GCSE but not found any, and hasn’t really thought about how the FMSP might be involved. He had
attended the academy chain conference, noting there were over three thousand teachers there, and there were speakers and workshops, but what he mostly got from it was contacts. He noted that a forum had been set up that might develop. He believed that not a lot of mathematics teachers from schools in the chain had any experience of teaching Further Mathematics, so there was opportunity for the FMSP to help in development of skills and knowledge of these teachers, but gaining access to them through a route other than school/AC contact is something the FMSP will need to investigate.

5.2.7 Further Mathematics and admission to university

As the number of students studying Further Mathematics has grown over recent years, some universities have reviewed their undergraduate admission policies for mathematics and related degree courses. Some universities now require Further Mathematics as an entrance requirement, whereas some don’t actually require it but prefer applicants to have studied Further Mathematics. The current admission requirements of universities that offer STEM (science, technology, engineering, mathematics) courses, was reviewed by the FMSP by checking this information on each university’s website and in their prospectus. The results are shown in Table 5.11.

Table 5.11 Mathematics and Further Mathematics entry requirements for a range of STEM courses at university.

<table>
<thead>
<tr>
<th>Course</th>
<th>UCAS code</th>
<th>Mathematics Required</th>
<th>Mathematics Preferred</th>
<th>Further Mathematics Required</th>
<th>Further Mathematics Preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Engineering</td>
<td>H8</td>
<td>96%</td>
<td>4%</td>
<td>0%</td>
<td>18%</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>H3</td>
<td>95%</td>
<td>3%</td>
<td>0%</td>
<td>21%</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>H6</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>H2</td>
<td>94%</td>
<td>4%</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>G1</td>
<td>100%</td>
<td>0%</td>
<td>9%</td>
<td>37%</td>
</tr>
<tr>
<td>Physics</td>
<td>F3</td>
<td>98%</td>
<td>2%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>F1</td>
<td>10%</td>
<td>10%</td>
<td>0%</td>
<td>4%</td>
</tr>
<tr>
<td>Biology</td>
<td>C1</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>G4</td>
<td>25%</td>
<td>16%</td>
<td>0%</td>
<td>7%</td>
</tr>
</tbody>
</table>

The vast majority of universities require A level Mathematics for entrance to an engineering course, and all require it for a mathematics degree course. However, Further Mathematics is only required for a mathematics degree course by 9% of the universities, but not for any other STEM courses. However, it is seen to be preferred, again for a mathematics degree course and engineering courses.

Further insight into the expected pre-course qualifications and experience of potential undergraduates, was sought through interviews with admissions tutors. This focused on mathematics degrees and mathematics combined with other subjects. Four such interviews took place.

One admissions tutor was from a university that required Further Mathematics. He advised that successful applicants must achieve a grade A* in Mathematics and a grade A in Further Mathematics. He did say they would consider applicants with a grade A in AS Further Mathematics.
but such applicants must also have achieved at least a grade 2 on a STEP paper or merit on the Advanced Extension Award.

Another admissions tutor described how his department’s requirements have changed over recent years, and whereas a few years ago they didn’t insist on Further Mathematics, they now do. He noted they can fill about 90% of their 200 places for mathematics and mathematics related degree courses with applicants who have a grade A* in both Mathematics and Further Mathematics. He noted that it was policy in his university not to base any offers on an AS qualification. He advised that they are now requiring Further Mathematics as previously they experienced over recruitment. He noted they wanted to be fair to all potential applicants, but they now considered that as Further Mathematics was available to all students through the FMSP, that they were being fair. He noted the requirement for Further Mathematics is in their prospectus, and he isn’t aware of any discontent or complaints. He did note however, there is some flexibility for offers to applicants from low participation neighbourhoods, in which they can consider the AS level in Further Mathematics. However, he did say they had increased the difficulty level of the mathematics in the first year of the degree course, as through having studied Further Mathematics and achieved an A* in the A level, the undergraduates were generally better mathematicians than in previous years.

The admissions tutor at another university, explained that although they prefer applicants to have studied Further Mathematics, they do not insist on it as an entry requirement. Their usual offer is three grade As including Mathematics, although this might be reduced if an applicant had studied Further Mathematics. He noted that the advice in their prospectus and on their website, is an offer of AAB is likely if an applicant is studying Further Mathematics and they could be flexible about the AS level. He noted that applicants to whom an offer has been made are invited to an open day, where Further Mathematics and entry requirements could be discussed with staff. He noted that they have 200 places to offer on mathematics and related degree courses, but they do get quite wide fluctuations in the applicants and their potential qualification, and so the department does need to be flexible in its offers. The department hasn’t actually done any analysis of whether having studied Further Mathematics gave an undergraduate an advantage, but he thought greater pre-course exposure to mathematics could only be for the good.

At the fourth university they have no requirement for Further Mathematics and their usual offer is a grade A in A level Mathematics and a B and C in two other subjects. For their dual awards, mathematics and another subject, the offer is lower at three grade Bs. He advised that there had been a lot of discussion within his department about the Further Mathematics issue; some didn’t want to discourage applicants who could only offer the single A level. However, the department holds open days for potential applicants and at those, the study of Further Mathematics is encouraged. He thought the department might move to a point where they don’t insist on Further Mathematics as an entry requirement but will make a lower offer to an applicant who had studied it. He noted that the number of undergraduates who had studied Further Mathematics varied over recent years, but currently it was about half of the undergraduates in the first year. He thought that studying Further Mathematics gave undergraduates a head start, but noted there are relatively few with the qualification who get the best degrees, although none tend to fail. He thought the big advantage in taking Further Mathematics is that it requires a deeper understanding than the more process driven main A level, where students can be taught to pass the examination. He noted taking
Further Mathematics is more akin to how it will be at university. He did note however, that they have admitted applicants whose only mathematics qualification was a grade C in the single subject, and they went on to achieve good degrees. However, he did note what he believed to be the influence of the FMSP, in that they had over 1000 applicants for the 2014 intake. He thought that through taking Further Mathematics, students were gaining greater insights into mathematics and finding it interesting and they want to do mathematics on a mathematics degree course rather than apply it in other areas.

Conclusion
The four admissions tutors interviewed show quite a contrast in their requirements concerning admission to mathematics or mathematics related degree course and Further Mathematics. Just how representative this is of all the universities in England isn’t known, but it seems likely that offers to applicants will be adjusted so that the departments in the universities continue to attract applicants. Some clearly attract very able applicants and can insist on the top grades in Further Mathematics. Most don’t insist on Further Mathematics but do encourage students to have studied it. There are advantages to having studied Further Mathematics for entry to a degree course, but it is not seen in some universities as essential. However, this may change as more students study Further Mathematics.

5.3 Stakeholders’ views of the FMSP
A number of stakeholders in mathematics education and Science Technology Engineering Mathematics (STEM) related subjects were contacted to solicit their views on the FMSP and its activities.

Those contacted include university academics (mostly from mathematics departments), school/college teachers, local authority employees and representatives of national STEM organisations. Views were invited by email and a number of responses were received, varying considerably in length and detail, but all are overwhelmingly generally positive about the FMSP and what it has achieved. These responses are appended, largely unedited, at Appendix H.

Four general themes were identified in the 30 responses received. These four themes are:

1. Raising the profile of mathematics, including an increasing number of students taking A level Mathematics and Further Mathematics, students being better prepared to enter Higher Education courses and the enthusing of Key Stage 4 students to continue to study mathematics post-16.

2. Networking and collaboration between the FMSP Area Coordinators, teachers in schools, colleges, and universities, local authority officers and other stakeholders.

3. Opportunities for teachers for professional development and the long term benefits of teachers who have been up-skilled in their subject knowledge and ideas for classroom practice.

4. The FMSP as a provider of valuable services to mathematics education.

These four themes are supported by quotes extracted from the responses, as below. The references refer to the actual responses in Appendix H.
1. Raising the profile of mathematics

The programme is expanding and has excellent national and regional leadership. The open days that expose further maths students and prospective students to some of the frontiers of mathematics and its applications are an important feature of the project.

Professor John Barrow FRS University of Cambridge ref.5

The continued expansion and success of the programme, including valuable CPD for teachers, means that we get up to ten applications for each of our places with almost all having taken the full A-level. ...We are currently making our first year lectures even more challenging as a result. So the FMSP has supported our university teaching.

Dr Robert Bowles University College London ref.7

The Further Mathematics Support Programme has played an invaluable role in creating a bridge between school and university level mathematics. To be able to offer students the possibility to do Further Mathematics I believe has contributed to the increased uptake in mathematics at University.

Professor Marcus de Sautoy University of Oxford ref.9

The FMSP has been successful beyond best expectations. It has evidently had a massive impact on the take-up of Further Mathematics A-level both by its direct provision of support and by its influence on A level provision in schools. From the point of view of ambitious HE it is far and away the most important initiative in Maths education in the last 10 years.

Professor Martin Hyland University of Cambridge ref.20

The FMSP has made an important contribution to the increased popularity and awareness of the Further Mathematics A-level and the subject in general. ...we have seen a steady increase in the number of students starting a mathematics degree with an A-level in Further Mathematics and the overall quality of applicants to our programmes. I believe this is partly due to the excellent work done by the NW centre of the FMSP.

Dr Louise Walker University of Manchester ref.29

2. Networking and collaboration

The Further Maths Support Programme (FMSP) continues to provide an invaluable service to both our secondary schools within Gateshead LA and across the North East region as a whole. The success is also largely due to the hard work and professional dedication of the two FMSP regional coordinators who have adapted their strategies and work with schools very well to meet the changes in direction and approach required by the government and FMSP, such as more focus on the Key Stage 4 students as an early introduction to Further Maths.

Dave Adamson Gateshead Local Authority ref.1
We have been very successful in rejuvenating further maths in Northampton. Over the years we have worked with a dozen or so local schools and colleges in a variety of ways. We have helped a few schools establish FM by tutoring for a year and then supporting them to take it in-house. We continue to help others by providing tuition here at the University of Northampton.

Bob Ansell  Northampton University  ref.2

Kingston and its surrounding areas are fortunate in having some excellent schools which were already offering FM and through the work of the Kingston Centre and its superb manager, Jenny Davey, over the past 6 or 7 years many other schools have also been able to offer their pupils this qualification. ...our involvement in the FMSP has created and cemented links between our School and the local secondary sector which might not otherwise have occurred.

Dr Nigel Atkins  Kingston University  ref.4

On a more local level for the impact on our students and staff at Little Heath School (LHS), having Jeff Trim as the Area Co-ordinator has been incredibly valuable for outreach work as part of our Science and Mathematics Specialism amongst local schools. Having host days at LHS and running the local KSS network meetings at the school has also enhanced the growing sense of “Mathematical Community” amongst Berkshire Mathematics teachers.

Gerry Dowling  Deputy Head Little Heath School  ref.10

The University of Reading has benefited greatly from being part of the Further Maths Support Programme, not least because of the contact it has had with local maths teachers and pupils, and the joint ventures that they have been involved in, and look forward to continuing this partnership as the Programme develops further. We very much value the contributions the programme has made over the years.

Dr Paul Glaister  University of Reading  ref. 13

Our current final year is nearly three times the number of 5 years ago, with a six-fold increase in those entering with full A-level Further Maths. The interaction with local schools brought about by our involvement with the FMSP is, in my opinion, the greatest single reason for this increase. ...

The collaboration with local schools has helped enormously to raise aspirations in socially challenging local areas. In my opinion, this has had a significant positive impact at Keele far wider than just within mathematics.

Professor Graham Rogerson  Keele University  ref. 27

3. Opportunities for teachers for professional development

CPD for teachers has expanded very significantly in the last couple of years. I attended the first CPD session 3 years ago and now there are regular sessions in two locations in the University of Liverpool and also in Chester. Martin also goes into individual schools or clusters on request. There was also an experimental STEP/AEA session recently in the University of Liverpool which I looked in on: this involved teachers and students from local schools working with questions from these demanding examinations, under the guidance of three experienced tutors.

Professor Peter Giblin  University of Liverpool  ref.12
I think we have reached a stage where enough schools now have teachers able to teach further maths (both in terms of expertise and time). What we need to do is to support them in doing so. The FMSP provides a number of opportunities for teachers of mathematics to develop their knowledge and teaching skills across a range of modules in both A level maths and further maths, including STEP and AEA level maths. This is much more cost effective, since the benefit from one teacher over several years is to many students.

Professor John Greenlees  University of Sheffield  ref.15

Extended activities to Key Stage 4 for improvements in A/A* GCSE Maths is laying the foundation for greater achievement in A/AS GCSE for future students. These activities are going hand-in-hand with broader local support mechanisms to Schools and CPD in AS/A2 Maths / Further Maths both on-line centrally but also to regional events.

Professor Stephen Hibberd  University of Nottingham  ref.17

It was noted that the numbers of entries in both Further Maths and Maths “A” levels were steadily increasing over the period and FMSP was acknowledged to be a key factor in this success. Not only were more pupils enabled to study further maths but by supporting maths teachers more generally the quality of maths teaching has undoubtedly been enhanced.

Dame Julia Higgins  Chair ACME  2008-2012  ref.18

Our area coordinators in Nottingham and Loughborough continue to offer a very wide variety of enrichment events. Recent events include ‘Suspense’ and ‘Rollercoaster’, which each attracted about 150 school children, Saturday morning master classes, Maths in the Environment and Maths in Fashion workshops, STEP and AQA classes and CPD for teachers in this area. There were Year 10 and Year 12/13 challenges, attracting a large number of teams from across the region. The effect of these events is to raise the profile of mathematics and its study at A-level and beyond. They are very popular with local schools. CPD for teachers continues to feature strongly in our provision.

Dr Carol Robinson  Loughborough University  ref.26

4. The FMSP as a provider of valuable services to mathematics education

The resources provided for students (and teachers) by the FMSP are excellent, and the opportunity for both students and teachers to engage with a like-minded community is most valuable. In addition to the provision at FM, the support provided at Key Stage 4 by way of enrichment courses is exactly what is needed to add interest and challenge to the GCSE curriculum. The FMSP provides a point of contact for teachers seeking help and support in some key areas of the mathematics programme in schools; it is a most valuable resource.

Christopher Belsom  Chair IMA schools and FE Committee  ref.6

We very much welcome this important means of widening the participation of students at Bath. We are also very pleased that the FMSP is working with us to help in the training of students for the STEP exams which give a great challenge to our brightest students. I am also pleased to say that we use the resource materials of the FMSP as part of our training of the calculus first year courses.

Professor Christopher Budd  University of Bath  ref.8
It is indeed rare to be able to attribute improvement in the uptake of a STEM subject to a single intervention. But the reversal of long-term decline in Further Mathematics registrations at A level does seem to be due in large part to the FMSP. The evidence for this can be found in the abrupt upturn in fortunes as the FMSP began - after years of decline. There was no other action taking place at that time to explain the dramatic change.

Professor Matthew Harrison  Royal Academy of Engineering  ref.16

The FMSP shows what can be achieved when enthusiasm, initiative and superb organization are allied to a clearly understood and shared vision. I hope they will continue contributing such qualities to mathematics education for a long time to come.

Dr Niall Mackay  University of York  ref.21

The resources now available for IGCSE Further Maths (AQA) and A-level Applied have been invaluable. They provide an opportunity for students to develop independent learning skills so invaluable later on at university. They also give teachers an excellent bank of resources to use in lessons.

I find the FMSP to be responsive in meeting the needs of schools in the rapidly changing curriculum climate, creative in the resources they provide and complete in their coverage of the curriculum. The next phase for me would be to match up AEA/STEP resources to the A-level curriculum and have these readily available to teachers and students.

Dr Keith Noble  Poole Grammar School  ref.24

The Further Maths Support Programme is an extremely successful initiative which continues to go from strength to strength, reinvigorating itself to meet the fresh challenges set by its stakeholders and the wider society. It plays an essential role in raising the profile of mathematics, and in stimulating students to aspire to the next level of their studies. 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 Colin Sparrow  University of Warwick  ref.28

Conclusion from the Stakeholders’ views of the FMSP

The quotations above are taken from the 30 responses received from stakeholders. They are chosen to illustrate the four themes identified in the responses which support the views: firstly that the FMSP has been successful in raising the profile of mathematics; secondly the FMSP is enhancing opportunities for networking and collaboration between those involved in mathematics education; thirdly through a wide ranging programme of professional development opportunities the FMSP is enhancing the subject knowledge and teaching skills of teachers; and fourthly the FMSP is providing a valuable service to mathematics education in general. All the responses were overwhelmingly positive about the various services that the FMSP has to offer and what it is achieving in terms of a key role in increasing the number of students studying mathematics post-16 and the quality of students taking up mathematics and related subjects at university.
6. Update and feedback on current Further Mathematics Support Programme services and events

6.1 Senior Team Mathematics Challenge

The Year 10 Mathematics Competition

The Senior Team Mathematics Challenge (STMC) is a competition, managed by the FMSP, in conjunction with the United Kingdom Mathematics Trust (UKMT), in which teams of four students from the sixth forms of schools and colleges (Years 12 and 13) compete to answer challenging mathematics questions in a limited time period.

The figures in the table below show the growing interest amongst schools and colleges in entering this competition. The competition is open to establishments from both the independent and state sectors.

<table>
<thead>
<tr>
<th>date</th>
<th>Number of schools/colleges participating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013/14</td>
<td>1146</td>
</tr>
<tr>
<td>2012/13</td>
<td>1100</td>
</tr>
<tr>
<td>2011/12</td>
<td>1000</td>
</tr>
</tbody>
</table>

In 2012 the FMSP initiated a similar competition for Year 10 students, though not in partnership with the UKMT, and 1800 students took part.

The table below shows detailed data on the Year 10 Competition held in 2013.

<table>
<thead>
<tr>
<th>Number of teams participating</th>
<th>810</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of schools participating</td>
<td>568</td>
</tr>
<tr>
<td>Number of heats</td>
<td>61</td>
</tr>
<tr>
<td>Number of regional finals</td>
<td>7</td>
</tr>
</tbody>
</table>

The number of Year 10 students taking part in the competition was over 3000, which shows there is considerable and growing interest in schools in this enrichment opportunity for this age of student.

6.2 Statistics and feedback on the take up of professional development

6.2.1 Teaching Advanced Mathematics (The TAM course)

Introduction

The TAM course, as described on the FMSP website, is an extended professional development course for teachers wishing to develop their own subject knowledge and classroom practice in teaching A level Mathematics. The aims of the course are for participants to gain a deep understanding of Core Mathematics and the participant’s choice of Mechanics, Statistics or Decision Mathematics; to experience effective pedagogy at this level and receive support in embedding this into classroom practice and to reflect on related research into the teaching and learning of mathematics at this level.
TAM is a Masters-level accredited course and is offered through six universities across the country. To take part in TAM, teachers must be teaching mathematics at a level beyond GCSE throughout the academic year and take an active role in eight study days, spread across the year, focusing on A level Mathematics pedagogy. Participants study the contents of five A level modules with online support and complete assignments along with having two school or college visits from a tutor.

The TAM Masters cohort for 2012/13 started in June/July 2012 and completed in September 2013. Feedback was sought from participants by the FMSP at the end of their course using an online survey. Of the 116 participants, 101 (87%) had completed the survey by 1st October. The number of respondents from each TAM centre are shown below.

<table>
<thead>
<tr>
<th>University</th>
<th>London South Bank</th>
<th>Institute of Education</th>
<th>Warwick</th>
<th>Durham</th>
<th>Plymouth</th>
<th>Manchester Metropolitan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>participants</td>
<td>17</td>
<td>15</td>
<td>22</td>
<td>15</td>
<td>16</td>
<td>16</td>
<td>101</td>
</tr>
</tbody>
</table>

Participants were asked to rate aspects of the course on a four point scale

where 4 is excellent 3 is good 2 is adequate 1 is poor.

The aspects are as follows:

- Teaching ideas gained on the study days.
- Insights into mathematical concepts gained on the study days.
- Core Mathematics online sessions that you have seen (live sessions, recordings or both).
- Support (CPD day and/or online sessions) for your chosen applied module; (leave blank if you haven’t used this support).
- The feedback from your two lesson observations.
- The Integral resources.

The results of the survey from the centres that offered the TAM course in 2012/13 are shown below.

### Participants’ rating of aspects of the TMA course

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Responses</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching ideas gained on the study days</td>
<td>Responses</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>0%</td>
<td>0%</td>
<td>15%</td>
<td>85%</td>
</tr>
<tr>
<td>Insights into mathematical concepts gained on the study days</td>
<td>Responses</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>0%</td>
<td>0%</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>Core Mathematics online sessions that you have seen</td>
<td>Responses</td>
<td>1</td>
<td>2</td>
<td>55</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>1%</td>
<td>2%</td>
<td>54%</td>
<td>43%</td>
</tr>
<tr>
<td>Support (CPD day and/or online sessions) for your chosen applied</td>
<td>Responses</td>
<td>1</td>
<td>8</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>module; leave blank if you haven’t used this support</td>
<td>Percent</td>
<td>1%</td>
<td>11%</td>
<td>38%</td>
<td>49%</td>
</tr>
<tr>
<td>The feedback from your two lesson observations</td>
<td>Responses</td>
<td>0</td>
<td>1</td>
<td>19</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>0%</td>
<td>1%</td>
<td>19%</td>
<td>80%</td>
</tr>
<tr>
<td>The Integral resources</td>
<td>Responses</td>
<td>0</td>
<td>1</td>
<td>16</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
<td>0%</td>
<td>1%</td>
<td>16%</td>
<td>83%</td>
</tr>
</tbody>
</table>
Participants were asked to what extent they agreed with the statement ‘I would recommend the TAM course to others in my position’.

The 4 point scale ranged from 4 ‘strongly agree’, to 1 ‘strongly disagree’.

<table>
<thead>
<tr>
<th>I would recommend the TAM course to others in my position</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>Percent</td>
<td>1%</td>
<td>0%</td>
<td>9%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Participants were also asked about their teaching experience both in general and teaching A level Mathematics. The allowed responses were: 1 year, 2 years, 3 years, 4 or more years.

<table>
<thead>
<tr>
<th>Number of years teaching experience</th>
<th>Number of years teaching A level Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>1 year</td>
</tr>
<tr>
<td>2 years</td>
<td>2 years</td>
</tr>
<tr>
<td>3 years</td>
<td>3 years</td>
</tr>
<tr>
<td>4 or more years</td>
<td>4 or more years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 year</th>
<th>2</th>
<th>2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 years</td>
<td>24</td>
<td>24%</td>
</tr>
<tr>
<td>3 years</td>
<td>18</td>
<td>18%</td>
</tr>
<tr>
<td>4 or more years</td>
<td>57</td>
<td>56%</td>
</tr>
<tr>
<td>1 year</td>
<td>42</td>
<td>42%</td>
</tr>
<tr>
<td>2 years</td>
<td>26</td>
<td>26%</td>
</tr>
<tr>
<td>3 years</td>
<td>16</td>
<td>16%</td>
</tr>
<tr>
<td>4 or more years</td>
<td>17</td>
<td>17%</td>
</tr>
</tbody>
</table>

The participants were also asked to comment on their thoughts on the impact that the TAM course had on them. All the delegates gave a response, some brief, others in quite some detail but they were all positive, with many mentioning the improvement in their knowledge at this level, and their increased confidence to teach at this level. The TAM course continues to be very much appreciated by those who have taken part in it.

The flavour of the responses is shown in phrases used in the feedback such as:

- TAM is the best CPD course I’ve been on...
- TAM has had a big impact on my changing my teaching style...
- I am able to leave the textbook...
- There was lots of good quality support and resources...
- TAM increased my confidence to teach at this level...
- I have gained lots of ideas for teaching strategies...
- TAM gave me new perspectives on mathematics...
- I am willing to try innovative approaches to introducing topics...
- TAM has enabled me to be creative in my teaching...
- I can use the ideas from TAM with pre-16 students...

Many also mentioned how TAM has taught them to be reflective and to evaluate their own lessons and teaching practice.

TAM is clearly a very successful course for bringing more teachers into A level teaching, but more so enabling them to be innovative in their teaching, and reflective in their practice.
6.2.2 Teaching Further Mathematics (The TFM course)

Teaching Further Mathematics (TFM) is a professional development course for teachers who wish to develop their own subject knowledge and classroom practice in teaching A level Further Mathematics. Over a 14 month period the course aims to enable participants to gain a deep understanding of the pure mathematics content of A level Further Mathematics and also offers the option of considering applied mathematics materials. The course also aims to develop the confidence and skills of participants to teach Further Mathematics, focusing on subject knowledge and effective pedagogy. Participants are encouraged to reflect on their own pedagogy. The TFM course also aims to expand the participants’ mathematical horizons and enable them to explore links within mathematics.

TFM is designed for A level Mathematics teachers who are currently teaching Further Mathematics or who wish to teach it at some point in the near future.

During 2012/13 there were 82 participants, 56 of whom were from schools and colleges in the state sector.

At the end of the course participants were invited to respond to an extensive online survey about themselves, their reasons for taking the course and their views on the course itself. Here the focus is on the latter, and the feedback from the participants on how they found the course and its impact on their teaching. Responses were received from 55 participants, (67%).

There was a variety of questions in the survey, some asking participants to rate certain aspects of the course, to asking them to agree or disagree to some extent with statements made about the course or to answer questions inviting an open response.

Feelings and impressions about the course
In the first question on their feelings and impressions whilst doing the course, about 60% said they enjoyed it, and about 50% were able to keep up with the course schedule. Only about 12% found the work onerous but somewhat more said they felt threatened or demoralised at times. In contrast over 90% found it exciting and invigorating to be studying on this course.\(^8\)

Study days
Study days at Warwick University, are built into the course. These give participants opportunity to meet each other and course tutors and work together to do some mathematics at this level.

Attendance was normally expected to be 4 days although participants could attend an extra day if they wished. About 30% of the participants had attended for 4 days, about 10% for 3 days, with about 10% opting for the extra day; about 8% were unable to attend any study days. Those who had attended some study days were generally very satisfied with them. About 80% found the mathematical content to be about right, with over 90% saying the same about the teaching resources and teaching pedagogy tips, although about 8% would have liked more of the latter.

\(^8\) The figures given as responses are approximate percentages; as there were about 50 responses each participant is represented by about 2 percentage points.
Resources
Participants were asked about their usage of the TFM specific resources on the *Integral* website during the course and their intentions subsequent to the course. The responses ranged from never to all the time, but the two most common responses were sometimes and frequently with about 70% of the participants on course and rising to around 80% of the participants after the course. There was a similar response to non-specific TFM resources on the website. Thus well over 90% of the participants intend to continue to use the resources from the *Integral* website after completing the course.

Online sessions
About 65% of the participants said that they felt part of a group, or an online community as much of the studying was done through online sessions. Those that didn’t had problems taking part in the online scheduled sessions, due to other commitments. However, over 90% were satisfied with the level of online support they received either through the sessions and/or individual email support and about 90% felt able to approach tutors for further support. Participants were asked about their attendance at the online sessions. Responses ranged from all of them to none with about 5% in the latter category, but about 50% of the participants had been to at least half of the sessions. The sessions are recorded so that participants can access them at a later date, either because they missed the session or so they can review the content. Again there was a full range of responses, with about 7% not using the recordings at all, but again about 50% or more having listened to at least half the recordings and about 20% all of them, so the recordings are clearly found to be a valuable resource by some of the participants. This was reinforced by the participants’ responses to an open question about how effective they found the online sessions, with about 50% giving a very positive response about how useful they were. Other participants commented that they had had difficulties keeping up with the schedule, were too tired at the end of a teaching day to concentrate or just couldn’t attend, although one participant said he found the pace to be too slow.

Access to the recordings
When asked about how useful it was to have access to the recordings the positive response was much higher at around 95%, with those who had missed sessions grateful for the opportunity to catch up. Some others went over a session again to clarify some points for themselves, whilst some others used a session in preparing a lesson on the topic concerned. Others commented it was good to be able to review a session in your own time and many thought having access to the recordings was essential to their teaching of Further Mathematics. This underlines the importance of the recordings of the online tuition sessions as a valuable resource, and one the participants want to retain access to. About 70% of the participants thought the presentation of the sessions was about right, with the rest split fairly evenly towards too fast and too slow. All participants indicated they are still making some use of text books, with about 35% saying this is sometimes and about 60% saying they do so frequently.

Understanding v Memory
When asked about how much success on the TFM course depended on understanding rather than memory about half responded “a lot” and about 25% “a great deal”, with no participant thinking they could be successful relying on memory alone. About 90% of participants thought the tutors related the topics met in the course well; there were no negative responses to this question.
Additional support and resources / classroom practice
The participants were asked an open question about any additional support or resources they would have liked during the course. About 20% indicated they were happy with what had been provided. Additional support or resources mentioned by others included more study days, face-to-face tutorials, more teaching tips and strategies, PowerPoint presentations they could use and generally more time to do the course.

The participants were asked another open question as to whether the material they met during the course had an immediate impact in use in their classrooms. About 60% said yes it did, but often qualifying this as relating to certain modules. Others were not currently teaching Further Mathematics but hoped to be next year.

Participants were also asked if they were using the teaching style ideas they had met on the course with other groups of students, particularly with A level or GCSE students. Again about 60% indicated they were doing this, many mentioning use of resources and they used some of the teaching strategies with A level and Higher Tier GCSE groups. Some noted it was difficult, as yet, to assess any impact of this change in teaching style. Some said that taking TFM had given them the confidence to try a new approach with other students, whereas some implied they already used this approach.

About 80% of the participants said they were sharing resources and ideas from the course with colleagues, at least to some extent.

Self-esteem / confidence
Participants were asked how they felt taking TFM had affected their self-esteem. Most interpreted this as has it increased their confidence to teach Further Mathematics. About 70% gave a positive response with some saying that their increased knowledge and understanding had resulted in increased confidence to teach the material. Other participants were uncertain about this, and some felt they were still inexperienced.

Organisation of the course / advice to potential participants
Moving on to organisation of the course about 90% of the participants thought the course to be very well organised, with no negative responses and over 90% thought the amount of assignment work they were given was about right, with only a few saying it was too much or too little. When asked if they would recommend the course to other teachers about 95% said yes they would, some unreservedly. A few weren’t sure and one said the course was too easy! When asked what advice they would give to undecided teachers on whether to take the course, a common response was ‘just do it, it is worth while taking this course’. Other advice included ensure you have the time and understand the commitment involved; it is challenging and hard work but the work load isn’t overbearing, but you need to keep to the schedule. The course was said to be informative and interesting and some offered the advice ‘if you want to teach Further Mathematics do this course; it is essential.’

TFM as a CPD course
Finally the participants were asked to rate TFM as a professional development course. Out of 52 responses, 50 found it to be at least good, and of these 22 found it excellent and 18 the best course they had ever been on. When asked to comment, common phases included: enjoyable; informative; supportive; well organised; exciting; good opportunities to do some maths; study days were good;
increased confidence; very worthwhile. There were some negative comments including not at the appropriate level for me; aimed at too broad a spectrum of teachers and too much emphasis on the topics rather than teaching them. These negative comments came from a few individuals and the feedback from the vast majority of participants is positive.

Conclusion
The TFM course clearly gives a large boost to teachers in their subject knowledge, ideas for teaching strategies and the confidence to teach at this level. The course would clearly benefit others with aspirations to teach Further Mathematics and so the FMSP should clearly continue to offer this course.

6.2.3 Other professional development opportunities
Table 6.1 summarises teacher participation from four professional development opportunities offered by the FMSP during 2012/13. These are:

- Regional professional development courses
- Live online professional development courses (LOPD, detailed in Section 3.2)
- The Sixth Term Examination Paper / Advanced Extension Award events (STEP / AEA detailed in Section 3.3)
- The Key Stage 4 Enrichment and enhancement events (E&E, detailed in Section 3.4)

Table 6.1 Teacher participation in CPD events 2012/13

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of events</th>
<th>Number of teachers</th>
<th>Number of schools represented</th>
<th>Number of teacher days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional events</td>
<td>62</td>
<td>639</td>
<td>595</td>
<td>639</td>
</tr>
<tr>
<td>LOPD</td>
<td>30 online courses</td>
<td>173</td>
<td>164</td>
<td>343</td>
</tr>
<tr>
<td>STEP / AEA</td>
<td>23</td>
<td>353</td>
<td>363</td>
<td>353</td>
</tr>
<tr>
<td>E&amp;E</td>
<td>23</td>
<td>395</td>
<td>312</td>
<td>312</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>1546</td>
<td>1434</td>
</tr>
</tbody>
</table>

It is notable that across all of these events that on average, participants generally find them to be at least good with many finding them to be excellent.
6.2.4 FMSP Associates events

There were two events held for FMSP Associates (previously known as Tutors). These were held in London where 26 Associates attended, and in Leeds where 24 Associates attended. Area Coordinators were invited to attend, with 10 attending in London and 6 in Leeds.

In the feedback from these two events, all delegates were asked to rate the event on the four point scale, on five aspects of the event. These five aspects were:

- The information about the conference available in advance of the event.
- Organisation during the conference.
- The suitability of the venue and the equipment.
- Lunch and refreshments at the venue.
- The overall content.

The four point scale is

<table>
<thead>
<tr>
<th>Excellent: 4</th>
<th>Good: 3</th>
<th>Adequate: 2</th>
<th>Poor: 1</th>
</tr>
</thead>
</table>

The results are summarised in Table 6.3

<table>
<thead>
<tr>
<th></th>
<th>Information in advance</th>
<th>Organisation</th>
<th>Venue and equipment</th>
<th>Lunch and refreshments</th>
<th>Overall content</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>3.9</td>
<td>3.9</td>
<td>3.4</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Leeds</td>
<td>3.7</td>
<td>3.7</td>
<td>3.6</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Overall</td>
<td>3.8</td>
<td>3.9</td>
<td>3.5</td>
<td>3.6</td>
<td>3.8</td>
</tr>
</tbody>
</table>

There is little difference in the average responses between the two venues, with most delegates finding all five aspects to be at least good, with some rating them as excellent. There were very few 2’s in the original feedback. Delegates were invited to make comments and these were generally very positive although several at London commented on the somewhat cramped conditions and at Leeds there were some internet connectivity problems. As far as the events themselves were concerned comments were along the lines of how informative it had been and it was a good to have the opportunity to meet other Associates and discuss matters relating to their role and the FMSP with them and the ACs. Most found it to be a well organised and comprehensive day.

6.2.5 The Access to Further Mathematics events

Access to Further Mathematics events were initiated by the FMSP in 2011 with the aim of encouraging the introduction of Further Mathematics in schools and colleges that don’t currently offer it and to help improve and develop provision in those that have recently introduced Further Mathematics. Events were held in four venues in England. Similar events were held in 2012 and 2013.

In 2013 the events were held at three venues located in London, York and Warwick.
The aims of the event were to:

- Consider practical and effective ways to run Further Mathematics.
- Examine the benefits to students, staff and schools/colleges of doing so.
- Introduce a variety of resources to support Further Mathematics teaching.
- Look at ways to sustain provision through teacher development and student participation.

Feedback from delegates on how they found the event is summarised in Table 6.4. The figures are for the average feedback score at each venue and the overall scores using the rating scores below:

- Excellent: 4
- Good: 3
- Adequate: 2
- Poor: 1

The four aspects were:

- The course content and resources
- Course delivery
- Venue and refreshments
- Information received in advance of the course

### Table 6.4 Feedback from the events Access to Further Mathematics

<table>
<thead>
<tr>
<th>Venue</th>
<th>Number of delegates</th>
<th>The course content</th>
<th>Course delivery</th>
<th>Venue and refreshments</th>
<th>Information received in advance of the course</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>33</td>
<td>3.6</td>
<td>3.6</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>York</td>
<td>13</td>
<td>3.8</td>
<td>3.9</td>
<td>3.8</td>
<td>3.0</td>
</tr>
<tr>
<td>Warwick</td>
<td>21</td>
<td>3.6</td>
<td>3.6</td>
<td>3.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>3.7</td>
<td>3.7</td>
<td>3.8</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Delegates were also asked if the course had met the stated aims. Out of the 67 delegates, 64 responded yes with the other 3 not answering.

The above figures show that the Access to Further Mathematics events continue to be very successful in meeting their aims.
6.3 Student tuition by the FMSP

6.3.1 Data on students who received tuition through the FMSP

Table 6.5 shows the number of students who received tuition from FMSP tutors for the last four years.

<table>
<thead>
<tr>
<th>year</th>
<th>Students</th>
<th>units(^9)</th>
<th>Face to face units</th>
<th>LOT(^{10}) units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009/10</td>
<td>816</td>
<td>1977</td>
<td>1780</td>
<td>197</td>
</tr>
<tr>
<td>2010/11</td>
<td>607</td>
<td>1525</td>
<td>1207</td>
<td>318</td>
</tr>
<tr>
<td>2011/12</td>
<td>435</td>
<td>1108</td>
<td>891</td>
<td>217</td>
</tr>
<tr>
<td>2012/13</td>
<td>373</td>
<td>913</td>
<td>711</td>
<td>203</td>
</tr>
</tbody>
</table>

Students take 3 units on the AS course and 6 units on the full A level course.

It can be seen that the number of students has been decreasing year on year, but the FMSP believe now the number will stabilise around 400. This is because these students are largely coming from schools and colleges who find it difficult to offer Further Mathematics ‘in-house’. This is reflected in the live online tuition (LOT), being a greater proportion of the units taught by the FMSP where the support is often to one or two students in a school or college.

6.3.2 Feedback from students who received tuition through the FMSP

Students who were tutored by the FMSP during 2012/13 were surveyed about their experiences after the end of the academic year in summer 2013. There were responses from 64 students. Their responses to the questions asked in the survey are shown in Table 6.6.

The students’ responses to these five aspects of tuition show that the vast majority of students are very satisfied with the tuition they have received. Over 90% of the students found the first four aspects to be at least good with many finding them excellent, with a similar number of nearly 90% for the availability and access to their tutor.

<table>
<thead>
<tr>
<th>aspect</th>
<th>excellent</th>
<th>good</th>
<th>adequate</th>
<th>poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall standard of tuition provided by the FMSP</td>
<td>52%</td>
<td>41%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Your enjoyment of the course</td>
<td>54%</td>
<td>43%</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>Setting and follow up to homework</td>
<td>38%</td>
<td>54%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>The usefulness and quality of the <em>Integral</em> online resources for Further Mathematics</td>
<td>41%</td>
<td>51%</td>
<td>7%</td>
<td>2%</td>
</tr>
<tr>
<td>The availability and accessibility of your FMSP tutor to support you with any individual queries you may have had</td>
<td>53%</td>
<td>34%</td>
<td>8%</td>
<td>5%</td>
</tr>
</tbody>
</table>

---

\(^9\) Units refer to individual mathematics modules such as FP1 (Further Pure 1) and M2 (Mechanics 2)  
\(^{10}\) LOT refers to Live Online Tuition
6.3.3 Data on student revision sessions

The FMSP continues to offer online revision sessions for students in some of the modules of A level Mathematics and Further Mathematics. The number of sessions offered and the take up by students in two recent examination series are shown in Table 6.7

Table 6.7 Student revision sessions and number of attendees

<table>
<thead>
<tr>
<th>Sessions</th>
<th>Attendees</th>
<th>Views of recordings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter 2012</td>
<td>36</td>
<td>719</td>
</tr>
<tr>
<td>Summer 2013</td>
<td>54</td>
<td>3276</td>
</tr>
</tbody>
</table>

The summer figures are considerably higher than the winter figures as far more students enter examinations in the summer than in the winter. It is notable that far more students make use of the recordings of sessions than actually watch them live. It would appear also that many students who sat their examinations in the summer of 2013 made use of the recordings from winter 2012. Students clearly find these revision sessions provided by the FMSP to be useful in preparing for their examinations and the FMSP should continue to offer this service.

6.4 Data on the take up of AS and A level Further Mathematics

6.4.1 National data

Table 6.8 shows the number of establishments that offered A level Further Mathematics in 2010/11 and A level and AS level Further Mathematics in 2011/12, using data from the Department of Education (DfE). More categories of type of school or college were introduced in 2011/12.

Table 6.8 National data on types of establishments that offer Further Mathematics

<table>
<thead>
<tr>
<th>Type of establishment</th>
<th>2010/11 AL FM</th>
<th>Type of establishment</th>
<th>2011/12 AL FM</th>
<th>AS FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academy</td>
<td>52</td>
<td>Academy</td>
<td>383</td>
<td>412</td>
</tr>
<tr>
<td>City Technology College</td>
<td>2</td>
<td>Agriculture and Horticulture College</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Community school</td>
<td>468</td>
<td>City Technology College</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Foundation School</td>
<td>295</td>
<td>Community school</td>
<td>324</td>
<td>355</td>
</tr>
<tr>
<td>Further Education</td>
<td>169</td>
<td>Foundation School</td>
<td>171</td>
<td>192</td>
</tr>
<tr>
<td>Voluntary Aided School</td>
<td>219</td>
<td>Free School</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Voluntary Controlled School</td>
<td>52</td>
<td>Further Education Sector Institution</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Other government funded</td>
<td>4</td>
<td>General Further Education College</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ministry of Defence funded College</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total state establishments</td>
<td>1261</td>
<td>Sixth Form Centre / Consortia</td>
<td>63</td>
<td>66</td>
</tr>
<tr>
<td>Independent schools</td>
<td>413</td>
<td>Sponsored Academy</td>
<td>48</td>
<td>60</td>
</tr>
<tr>
<td>Non-maintained special school</td>
<td>3</td>
<td>Tertiary College</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voluntary Aided School</td>
<td>172</td>
<td>193</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voluntary Controlled School</td>
<td>39</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>1677</td>
<td>Total state establishments</td>
<td>1303</td>
<td>1447</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Independent schools</td>
<td>414</td>
<td>370</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>1717</td>
<td>1817</td>
</tr>
</tbody>
</table>
Although the classification of establishments has changed, the total number of establishments that offer Further Mathematics in the state sector has continued to grow, there being 1261 in 2010/11 and 1303 in 2011/12.

The growth in the number of establishments that offer Further Mathematics is further illustrated in Table 6.8 using data from the DfE. Table 6.9 shows a comparison of the establishments that offer A level Further Mathematics with those that offer the main A level in Mathematics over the last eight years to 2011/12.

**Table 6.9 Changes in the number of establishments that offer, or who do not offer, A level Mathematics and A level Further Mathematics – 2004/05 to 2011/12**

<table>
<thead>
<tr>
<th>Year</th>
<th>Establishments that offer Further Mathematics</th>
<th>Establishments that offer A level Mathematics</th>
<th>Percentage access to Further Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004/05</td>
<td>762</td>
<td>1926</td>
<td>40%</td>
</tr>
<tr>
<td>2005/06</td>
<td>882</td>
<td>1904</td>
<td>46%</td>
</tr>
<tr>
<td>2006/07</td>
<td>962</td>
<td>1896</td>
<td>51%</td>
</tr>
<tr>
<td>2007/08</td>
<td>1059</td>
<td>1882</td>
<td>56%</td>
</tr>
<tr>
<td>2008/09</td>
<td>1131</td>
<td>1893</td>
<td>60%</td>
</tr>
<tr>
<td>2009/10</td>
<td>1171</td>
<td>1874</td>
<td>63%</td>
</tr>
<tr>
<td>2010/11</td>
<td>1226</td>
<td>1960</td>
<td>63%</td>
</tr>
<tr>
<td>2011/12</td>
<td>1303</td>
<td>1994</td>
<td>65%</td>
</tr>
</tbody>
</table>

Whilst there has been about a 70% increase in the number of establishments that offer Further Mathematics over these 8 years, the number offering A level Mathematics has remained fairly static. However, the number of the latter establishments that also offer A level Further Mathematics has grown from 40% to 65% as seen in the last column. This period covers the formation of the former Further Mathematics Network in 2005 and its transition to the Further Mathematics Support Programme in 2009, so this growth has occurred coincident with the development of the FMN and of the FMSP.

This growth in establishments is consistent with a growth in student numbers. Table 6.10 shows the number of graded entries for A level and AS level Further Mathematics for 2012 and 2013, using JCQ data.

**Table 6.10 Graded entries in Further Mathematics (JCQ data)**

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>A level Further Mathematics</td>
<td>12688</td>
<td>13232</td>
<td>4.3%</td>
</tr>
<tr>
<td>AS level Further Mathematics</td>
<td>20370</td>
<td>21986</td>
<td>7.9%</td>
</tr>
</tbody>
</table>

### 6.4.2 Change in status of schools and colleges registered with the FMSP

The FMSP tries to engage with all suitable schools and colleges across England to raise awareness of Further Mathematics, and mathematics in general. Establishments can register with the FMSP by completing a short online form. They are asked to do this each year to keep their information up-to-date and in order to receive continued ‘free’ access to the *Integral* resources. One aspect of this registration is to request the ‘FM Status’ of the registering establishment, as set out in the categories
below (note that the wording below is not that which is given in the online form, but that which is used to match with the FMSP Key Performance Indicators).

<table>
<thead>
<tr>
<th>FM status</th>
<th>Further Mathematics (FM) tuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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.</td>
</tr>
<tr>
<td>2</td>
<td>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 teaching.</td>
</tr>
<tr>
<td>3</td>
<td>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).</td>
</tr>
<tr>
<td>4</td>
<td>When there is demand, all teaching is provided by the FMSP.</td>
</tr>
<tr>
<td>5</td>
<td>The school/college does not offer FM to its students, or there is no evidence to suggest the subject is offered.</td>
</tr>
</tbody>
</table>

The evaluation considered how the Further Mathematics status of an establishment changed from 2010/11 to 2011/12 and from 2011/12 to 2012/13. Table 6.11 shows how the status changed between the two years being compared. It should be noted that categories 1 and 2 are amalgamated in Table 6.11 as they both indicate that Further Mathematics is taught ‘in-house’ (but in category 2 the school/college receives CPD from the FMSP).

**Table 6.11 Change in Further Mathematics (FM) status of establishments registered with the FMSP 2010/11 to 2012/13**

<table>
<thead>
<tr>
<th>2010/11 Further Mathematics status</th>
<th>2011/12 Further Mathematics status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 1323 25 12 42 1402</td>
<td>1/2 1766 45 22 86 1919</td>
</tr>
<tr>
<td>3 13 20 6 5 44</td>
<td>3 9 17 11 10 47</td>
</tr>
<tr>
<td>4 6 4 11 12 53</td>
<td>4 5 4 45 12 66</td>
</tr>
<tr>
<td>5 23 3 4 172 202</td>
<td>5 33 6 25 392 456</td>
</tr>
<tr>
<td>total 1365 52 53 231 1701</td>
<td>total 1813 72 103 500 2488</td>
</tr>
</tbody>
</table>

It is immediately notable from Table 6.11 that there appears to have been a large increase of 787 establishments that have registered with the FMSP; or about a 46% increase. However, the figures do need to be interpreted with caution as giving their FM status is optional for schools and colleges, but subsequent to 2011/12 they were encouraged to do so. The number of registered schools has remained fairly constant in recent years. Proportionally the number of schools that have not changed status has stayed about the same at 90% but another 674 establishments are now in this category. It is notable that there has been a small increase in the number of establishments where provision has reduced. The number of schools in category 5 has increased but many of these 392 establishments will be 11-16 schools, where no A levels are offered.
7. Conclusions and recommendations

Section 2  Area Coordinators and their perception of the role
The ten Area Coordinators (ACs) who were interviewed are clearly highly motivated individuals who are committed in delivering on the various aspects of their role, of which they all have a sound understanding. The role has changed substantially since the first introduction of the Further Mathematics Network, and subsequently the Further Mathematics Support Programme, but experienced and relatively new ACs adapt well to what is required of them. Small groups of ACs meet regularly with their Regional Manager from the FMSP Central Team to plan regional events. The ACs are thus kept well informed of developments in the FMSP and have opportunity to discuss and influence them both through face-face meetings and the AC’s online forum. The ACs are very well supported by the Central Team. There is no reason to doubt that all the current ACs are similar in their desire to enhance the experience of both students and teachers as they help to develop mathematics education in their area and nationally.

The FMSP should continue in its support of the ACs and their role and make further appointments when possible to involve more in the activities and development of the FMSP.

Section 3  Developments in FMSP professional development
Live online Professional Development (LOPD)
In the interviews, phrases like, “it was really good” and “I really enjoyed it” were common when teachers were asked to summarise their feelings from having taken a LOPD course. One teacher said she had been “really impressed” and another that “this approach should be used more”. Although nine teachers is a relatively small sample, there is a consensus from the teachers interviewed that taking a LOPD course is a very worthwhile experience that has enhanced their teaching. The feedback from the 41 participants across 13 courses supports this view with many rating the various aspects of the course as excellent.

It is notable that all of these participants would recommend the course to other teachers, which adds to the conclusion that the LOPD courses are a very successful format for continuing professional development. The FMSP should look to expand and develop their LOPD provision.

Sixth Term Examination Paper / Advanced Extension Award Event
The STEP / AEA event observed was a demanding day for the delegates as it covered a lot of ground, but this event clearly met a need as evidenced by the number of delegates attending the events held around the country. Both the telephone interviews and the exit evaluation forms indicate these events have been a success in meeting their objective of providing advice and resources so that teachers can support their students. Students should be better prepared for STEP / AEA examinations as a result of their teacher attending and more students should have support in preparing to take these papers if they wish to. More generally students should have opportunity to develop their problem solving skills, which will be good preparation for mathematics related higher education courses.

The STEP / AEA events are clearly meeting a need and achieving their objectives and should be continued by the FMSP.
Extension and Enrichment for Key Stage 4 students
The teachers at the observed event were fully engaged in the activities they were given to try out and in the associated discussion of their use in the classroom. They also willingly shared their experiences of using and adapting the materials in their own schools and supporting colleagues to do so.

The feedback from the 14 teachers interviewed, who had attended one of these two day events around England, is very positive. They have clearly got a lot out of attending, and through their attendance, so have their schools. The objectives of the course have been met for these teachers. Given the enthusiasm of the teachers at the observed event as well, that is probably quite universal amongst the delegates and is borne out by the summary of feedback from teachers at all the events in their exit evaluation forms, which indicated they found all aspects of the event to be at least good, with the course content and delivery particularly so. The conference on Extension and Enrichment held separately after all the two-day events had taken place was oversubscribed. This gives further support to the indication that there is strong teacher interest in the problem solving approach to teaching and learning mathematics. The feedback from the teachers who had attended this conference is again overwhelmingly positive.

Sustainability into the future looks probable, as many teachers said they are embedding this approach into their schemes of work and developing it across their school, but whether this approach will encourage students who otherwise at age 16 would not have opted for A level Mathematics, to opt for it, cannot be answered until this approach becomes widely embedded as normal practice pre-16. Recent changes in GCSE in moving towards assessment with an increased emphasis on problem solving is likely to see the problem solving approach develop significantly and thus enhance interest and motivate students to pursue the study of mathematics post-16.

The Extension and Enrichment events have clearly been very successful, and there is a demand from teachers for more such events, so the FMSP should develop the events following the feedback they have received and continue to provide these events around the country.

Section 4  Developments in FMSP tuition
Live Interactive Lectures for Further Mathematics (LIL FM)
Five teachers who have students who use the FMSP LIL FM sessions and the associated materials were interviewed for their views of LIL and the response from their students. The teachers seem to be content that LIL FM is providing what they wanted for their students in a cost effective manner and that students are benefiting from following the course. Teachers reported that students’ views varied but the vast majority were satisfied with the presentation of the sessions and their schedule. The teachers reported that their timetable time between sessions was used to prepare students for the next session as well as reviewing and discussing any points of difficulty. Apart from a few technical difficulties, which were soon resolved, there were no problems with the online virtual classroom.

The recordings of two live sessions were observed, and the quality of the presentation was found to be good, as were the presenters’ efforts to encourage the active participation of the students. Five teachers is a small sample but even so there is quite some variation in the reported views of how students are using LIL FM and the Integral resources.
The variation in how LIL FM is currently being used should be investigated further by the FMSP and taken into account when both developing LIL FM and promoting it to schools and colleges. LIL FM is clearly fulfilling a need in a flexible way and the FMSP should continue its development.

Section 5  Impact of the Further Mathematics Support Programme

Registration with the FMSP and take up of A level Further Mathematics.

The vast majority of state secondary schools who have sixth forms and thus offer A level subjects are registered with the FMSP, which compares with about one third of further education colleges. The number of schools without sixth forms, mostly 11-16 schools, who have registered has increased significantly in recent years with about half of these schools now registered. A small survey indicated that 11-16 schools are using, or are considering using, FMSP services.

It was found problematic to classify schools and colleges by the number of students who enter for A level Further Mathematics. Analysis of DfE data showed that across the state sector this varied from establishments who regularly enter more than 20 students to others where numbers are very small, and in some years, no students were entered. Numbers of students entered only related to type of establishment to some extent, in that some former sixth form colleges and schools with large sixth forms who offer many A level subjects, tended to have large entries in Further Mathematics, but not necessarily so. Smaller entries come from all types of establishment. However, the number of entries nationally to A level Further Mathematics has continued to grow year on year.

A survey was conducted with teachers from a range of establishments where entries to Further Mathematics varied from large to very small, to see how they currently offered the subject, their views on support from the FMSP and plans for future development. These results are presented as 11 case studies in the report. It emerged that there is little commonality between establishments and how they deliver Further Mathematics to their students. Some teach it all themselves to large numbers of students and have done so for many years, whereas others make use of face-to-face or online tuition from the FMSP, at least to some extent, whilst doing some of the teaching themselves. Some are content with the numbers of students they attract and don’t expect numbers to grow, whereas others hope numbers will increase, this often being associated with increasingly moving the teaching ‘back in-house’. All teachers surveyed valued the support available to them from the FMSP, particularly the opportunity for professional development, but take up of events and services varied.

Data analysis on the impact of introducing Further Mathematics to a school or college curriculum

A quantitative analysis was made using data from the DfE’s National Pupil Database (NPD) on entries to A level Mathematics and Further Mathematics, and the grades achieved by the students over the ten year period 2003 to 2012. The objective was to identify establishments that had introduced Further Mathematics during the period 2005 to 2010, and to ascertain how this had developed in subsequent years and also its effect on the numbers taking A level Mathematics and the students’ achievement. Initial analysis was carried out on each establishment, and it proved impossible to follow some over the ten year period as during this time they had changed their status or for other reasons changed their identification code on the NPD, or had closed. However, data did exist for many establishments over the ten year period and showed wide variation in the results. However, on aggregation up to national level, it was found that on average, once an establishment had
introduced Further Mathematics, that student numbers and their achievement grew, and this was mirrored by student numbers and achievement in A level Mathematics.

It can be concluded that there is a general trend that introducing Further Mathematics improves performance in A level Mathematics. Some teachers from the survey did put the belief that students who take Further Mathematics get an improved grade in A level Mathematics as a result, but whether there is such an effect on those who just take A level Mathematics would require a much more in depth analysis.

**Impact from the perspective of the Area Coordinators**

A survey was conducted amongst the 30 ACs to ascertain their views on what aspects of the FMSP had had the greatest impact. The ACs found this a difficult task, with many noting that the FMSP is flexible in meeting the needs of an individual school or college, and it is difficult to put the various services and activities of the FMSP into an order of importance as regards their impact. There was quite some variation amongst the AC’s views.

However, with that caveat, the survey indicated that in provision for teachers it was the provision of professional development opportunities for teachers that had had the greatest impact followed by advice to establishments on delivering Further Mathematics. For students, the greatest impact was felt to be in providing tuition in the various modules of Further Mathematics for those who could not otherwise access it, followed by enrichment events in mathematics for Key Stage 4 students.

On the organisation of the structure of the FMSP, the ACs mostly agreed that the greatest impact came from themselves, and the fact that they are regionally based, but many commented this was dependent on support from the Central Team and ultimately the funding provided through the DfE. This view was reiterated in follow up interviews with 15 of the ACs, where it was noted again that the great strength in the regional organisation is that ACs know the schools and teachers in their area and their needs and the teachers know them, and once contact is made with a teacher in a school or college, the relationship usually develops very positively. The ACs also noted that they can facilitate the formation and development of regional support teacher networks, creating a community of teacher practitioners who can be mutually self supporting. Some ACs noted the increasing involvement of 11-16 schools in FMSP activities, and how teachers in these schools are becoming more aware and developing a better understanding of opportunities available to students post-16. More generally the ACs noted how important it is for future take up of A level Mathematics and Further Mathematics to enthuse students currently in Key Stage 4, and that enrichment opportunities play a key role in this.

**Development of Further Mathematics in the Priority Schools**

The FMSP first approached schools, deemed to be priority schools in agreement with the DfE in 2011/12 and this work has continued. In the interviews with the ACs above, they were also asked about their involvement with the priority schools in their area and any developments. They noted that in some of these schools, Further Mathematics has been introduced and is becoming established, whereas there are other schools who have not responded to attempts to contact them. The ACs noted that having a named contact in a school is vital to subsequent development, and they continue to seek such a contact in schools that are reluctant to become involved with the FMSP.

It was discerned from these interviews that there are three essential factors to initiating the offer of Further Mathematics. Firstly there must a be a student who wishes to study it; secondly there must be a member of staff who wants the department to offer it however tuition might be arranged;
thirdly there must be senior management support. The ACs noted the introduction and development of Further Mathematics can be a slow and gradual process that may take several years, but that it is important to maintain contact with the school or college and offer support.

The interviews with the ACs were followed up with interviews with ten teachers from priority schools where Further Mathematics has been introduced. These schools mostly had small numbers of students and there was varying provision but this usually involved some tuition from the FMSP and some ‘in-house’ tuition. All these teachers were grateful to the AC concerned for the help and advice given in initiating Further Mathematics and contributing to its ongoing development. Some teachers had been on professional development courses and some had taken their students to enrichment events, but all were agreed that just knowing there is someone local and available they can turn to if they need help and advice was very reassuring. It is not just the offer of support for Further Mathematics, but mathematics education in general, that is very much valued.

These teachers indicate the positive developments that can ensue once a contact has been made in a priority school. The FMSP, through the ACs, should continue to support these schools and strive to establish contacts in those schools who have yet to show a positive response.

The FMSP and Teaching Schools and Academy Chains

Interviews took place with six teachers from schools that are both registered with the FMSP and also have national Teaching School status. Through their Teaching School status, these schools are developing alliances and partnerships with other local schools, the local university, the local authority and other interested parties. One of the prime purposes of these alliances and partnerships is professional development for teachers and involvement with initial teacher training. All the teachers noted that the FMSP is involved through the local AC who is offering advice, and in some cases is actively involved in planning and delivering professional development. One teacher highlighted the recent formation of a Mathematics Education Strategic Hub (MESH) in her area, a NCETM initiative, and that the AC is involved in its development.

It would seem that there is considerable opportunity for the FMSP to become involved and offer advice and guidance in the professional development and initial teacher training that Teaching Schools will offer and to become involved in local MESHs. This is another area in which the FMSP can help to facilitate the working together of experienced, newly qualified and trainee teachers to share experiences, teaching strategies and resources. The FMSP should pursue these opportunities vigorously.

There was only one interview with a teacher from an Academy Chain, and it seems such chains can have member schools from both primary and secondary sectors and that are disparately spread geographically. They also seem to have their own arrangements for professional development within a chain. What opportunity there might be for the FMSP to become involved in such chains is largely unknown, but it is recommended as something the FMSP should investigate.

Further Mathematics and admission to university

According to information found on university websites and in prospectuses, 9% of universities currently have A level Further Mathematics as an entry requirement for a mathematics degree, but no other STEM subjects whereas most courses require A level Mathematics and prefer applicants to have studied Further Mathematics.
This variation in admission requirements was reinforced in the interviews conducted with four admissions tutors. One university insisted on top grades in both Mathematics and Further Mathematics and filled its courses with applicants who could meet these requirements, whereas another had recently moved to this position, noting this was considered fair as all potential applicants had access to Further Mathematics through the FMSP. In the other two universities, although they don’t insist on applicants studying Further Mathematics they will consider making lower offers in terms of required grades to those who have. It was generally felt that through studying Further Mathematics applicants were better prepared for taking a mathematics related degree course than they would be through A level Mathematics alone.

Just how representative this is of all the universities in England isn’t known, but it seems likely that offers to applicants will be adjusted so that the departments in the universities continue to attract applicants. There are advantages to having studied Further Mathematics for entry to a degree course, but it is not seen in some universities as essential. However, this may change as more students study Further Mathematics. The FMSP should continue to monitor university entrance requirements, and liaise with admissions tutors in encouraging potential applicants to study Further Mathematics, whilst continuing to support schools and colleges so that their students can do so.

**Stakeholders’ views of the FMSP**

The responses from the 30 stakeholders who responded to the invitation to share their views on the FMSP, were overwhelmingly positive. These stakeholders included university academics, teachers, local authority officers and representatives of national STEM organisations.

Four themes emerged from the stakeholders’ responses, on where the FMSP had had significant impact. These four themes are:

- **Raising the profile of mathematics**, including an increasing number of students taking A level Mathematics and Further Mathematics, students being better prepared to enter Higher Education courses and the enthusing of Key Stage 4 students to continue to study mathematics post-16.

- **Networking and collaboration** between the FMSP Area Coordinators, teachers in schools, colleges, and universities, local authority officers and other stakeholders.

- **Opportunities for teachers for professional development** and the long term benefits of teachers who have been up-skilled in their subject knowledge and ideas for classroom practice.

- **The FMSP as a provider of valuable services** to mathematics education.

The range of responses shows that the work and achievements of the FMSP are recognised throughout stakeholders in STEM education. The FMSP should continue to be involved in active discussion and liaison with the organisations these stakeholders represent to try and ensure that their needs are being addressed.
Section 6 Update and feedback on current FMSP services and events

Senior Team Mathematics Challenge / Year 10 Mathematics Competition
The number of teams competing in the Senior Team Mathematics Challenge for Year 12 and 13 students has continued to grow. The recently introduced competition for Year 10 students has attracted considerable interest. Feedback from teachers who have students who have participated in these events say that the students enjoy them. The FMSP should clearly continue these events and encourage even greater participation.

Statistics and feedback on the take up of professional development

Teaching Advanced Mathematics (TAM) and Teaching Further Mathematics (TFM)
These two extended professional development courses, continue to get very positive feedback from the participants. They continue to attract participants and the TAM course has now expanded to be offered by six universities. In both courses participants generally feel both their knowledge and understanding of mathematics has been enhanced, they have been shown and used a range of resources and teaching strategies for use in the classroom and their confidence to teach mathematics has significantly improved. The courses are clearly meeting a need and the quality of the courses is demonstrated by the fact that the vast majority of participants would recommend these courses to other teachers. The FMSP should clearly continue to offer these two courses.

FMSP Associates’ events
The two events held for Associates were also attended by some of the ACs. The feedback from the 50 Associates who attended, through exit evaluation forms, showed that they found the event to be at least good, with many of the Associates rating some aspects of the event as excellent. They valued the opportunity to meet each other and discuss matters relating to their role between themselves and with the ACs present. These events are clearly valued by the Associates, and the FMSP should continue to give the Associates the opportunity to meet and discuss their role within the FMSP organisation.

The Access to Further Mathematics events
Teachers and managers from schools and colleges who do not offer Further Mathematics or have only recently introduced it are invited to these events. Three such events took place in 2013. The feedback from the 67 delegates who attended, through the exit evaluation forms, was found to be at least good with many of the delegates rating some aspects of the event as excellent. The aims of the event were felt to have been met by the vast majority of the delegates. These aims included showing how Further Mathematics might be introduced, delivered and sustained, demonstrating resources to support the teaching, and illustrating the benefits to both the students and the school/college. These events are clearly playing an important role in encouraging more schools and colleges to introduce and develop provision in Further Mathematics and the FMSP should continue to hold them for establishments that they consider would benefit from attendance.

Student tuition by the FMSP; student revision sessions
The number of students who receive tuition from FMSP tutors either face-to-face or through Live Online Tuition (LOT) has fallen over the last few years as schools/colleges have taken teaching ‘back in-house’. The FMSP believes the number of students receiving tuition will settle at around 400.
Students are invited to complete a survey on the tuition and support they receive through the FMSP, and of the 64 completed surveys received in summer 2013, the vast majority were very positive about it. Students were asked about five aspects of their tuition and support including, the standard, homework, resources and their personal tutor, and of the order of 90% found these to be at least good, with a similar number saying they had enjoyed their course. The FMSP should clearly continue to offer tuition to students who cannot otherwise access it, and in flexible ways to best meet an individual student’s needs.

The FMSP offers revision sessions to all students of A level Mathematics and Further Mathematics in preparation for examinations, both face-to-face and online. These are well attended although the majority of the students seem to prefer to use a recording of an online session. This is a service provided by the FMSP that students make use of, and thus its provision should be continued.

Data on take up of AS and A level Further Mathematics

National data on state establishments that offer Further Mathematics show the number of establishments has continued to increase year-on-year. Using the latest figures available from the DfE, in 2011/12 there were 1303 establishments that offered the A level and 1447 that offered the AS level. The increase in the number of establishments is also seen in the increase in the number of student entries to Further Mathematics, this being 13232 for the A level and 20370 for the AS level, according to DfE data, increases of 4.3% and 7.9% on the 2012 data respectively. Although these increases cannot be attributed directly to the FMSP, the increasing range of activities and services provided by the FMSP to schools and colleges coincides with this growth.
Appendix A
Definitions of priority schools/colleges

A Further Mathematics eligible establishment is a state funded school or college offering A level Mathematics.

A priority school or college is a Further Mathematics eligible establishment which had greater than three A level Mathematics certifications but no AS or A Level Further Mathematics certifications as per the last available DfE data.

A priority 11-16 school is a school in which less than 30% of the students achieved grade A* or A in GCSE Mathematics in August 2012 and is in a ward in which 20%, or more, of the students are eligible for Free School Meals.

A highest priority school/college either has a deprivation index of at least 50% (according to the tax credit measure) or is in a ward in which more than 20% of pupils are eligible for Free School Meals (according to bespoke information provided by the DfE).
Appendix B

Detailed report following observation of two LOPD online sessions

The two sessions selected were from the programme for Further Pure Mathematics 1 (FP1). These were the second and third sessions in a 10 session programme, the first session being given over to making sure participants could access the virtual classroom and use the software to interact, as well as ‘meeting’ each other and the two presenters for the programme. These two sessions were on an introduction to matrices.

Session 1

There were five participants. The session started with the presenter again making sure the participants were able to use the software; she had a map of England on the Interactive Whiteboard (IWB) and asked participants to indicate their location, either typing or via their graphics tablet. Some were experiencing some technical problems, such as a failing microphone, but all were able to participate and communicate via the ‘chat box’.

The presenter than outlined what the participants would cover in the session, under the title Introduction to Matrices. She started with the question “what is a matrix?” and had several examples on a prepared slide on the IWB. She used these to introduce the term ‘order of a matrix’ and rows and columns, when two matrices can be said to be equal and the zero matrix. She asked the participants if any of them was currently teaching FP1 or had recent experience of matrices; it appeared no-one had so they had a common starting point.

The presenter moved onto matrix addition and subtraction again with examples on the IWB of when these operations are defined and when they are not. She extended this to multiplication by a scalar quantity, noting a scalar is any number and it is just repeated addition. The participants indicated they were happy with that so the presenter moved onto the somewhat more complex idea of multiplying one matrix by another. The idea of “multiply a row into a column” was illustrated skilfully on the IWB using graphics; the presenter noted how students need lots of practice with multiplication to gain confidence with how it is done. She also illustrated another way of doing the multiplication, the ‘Cayley Table structure way’ which she suggested some students find helpful.

The presenter introduced the term ‘conforming matrices’ and how this related to when the multiplication of two matrices is possible and when it is not. She then had several examples for the participants to have a go at multiplying two matrices, if the product was defined. She noted the helpful guide for students of, you can do the multiplication if the number of rows in one of the matrices is equal to the number of columns in the other. She asked for “smiley faces” if all participants were happy, and they were and so she invited them to try the examples for a few minutes. It was notable that no-one used the alternative ‘Cayley Table’ way. The presenter moved on to discuss whether the order of multiplication mattered and when could it meaningfully be reversed. She noted that this is often a difficult idea for students so it is a good idea to spend time in discussing it with them.

The presenter noted that matrices can seem rather artificial so she gave the participants some in-context examples where using matrices and matrix multiplication was a way of solving a problem, such as working out the points in a football league table. She showed a worksheet with a range of
contexts of such examples, using the ‘application sharing’ facility of the software, noting that participants could have access to this and suggested using some of these examples with students.

She then moved to a more formal treatment of matrix multiplication, introducing the idea of an identity matrix. She noted how students, although familiar with the idea of an identity in ordinary arithmetic, wouldn’t have used the term. She used examples to illustrate the form that the identity for multiplication must take, and suggested that participants do this with students to reinforce the idea. She also pointed out the identity for matrix addition.

The session continued with participants being shown a number of relevant examination questions but noted participants needed to check the requirements of their examination board’s specification for just what was required. For example, some boards require candidates to know the term ‘commutative’ whilst some do not. The presenter worked through the questions live using her graphics tablet, discussing what she was doing and what students should look out for.

The presenter moved on to the formal terms of associative and commutative operations and the distributive law, again suggesting that students are already familiar with these ideas from algebra but will probably not have used these formal terms. She used this to raise the question, which students might well raise, of “can we divide one matrix by another?” She introduced the term ‘inverse’, again noting it is familiar but not specifically using the example $\frac{10}{5} = 10 \times \frac{1}{5} = 10 \times 5^{-1}$ and that we can look for an equivalent way of doing division with matrices. Moving to the idea of an inverse matrix, she introduced the determinant of a 2x2 matrix, with some examples before giving the formal definition of the inverse of a 2x2 matrix, noting that for a 3x3 matrix it is somewhat more complicated. She suggested students need lots of practice with finding and using inverses to get the idea and that $A \times A^{-1} = I$ and $A^{-1} \times A = I$; the participants did their own practicing with some examples. The presenter then asked “what if the determinant is zero?” noting students find it strange that some matrices do not have an inverse. She noted that ‘singular’ and ‘non-singular’ matrices may be on some specifications as might knowledge of the result $(AB)^{-1} = B^{-1}A^{-1}$. She illustrated use of this result using some examination questions. She ended the session by showing the use of the inverse of a matrix in solving simultaneous equations in two variables and related this to the associated graphs; if the solution is unique then the graphs (straight lines) intersected at a point. She asked “what if the inverse doesn’t exist and the determinant is zero?” The participants suggested the lines would be parallel and there are no solutions. The presenter agreed with this, but then she gave another example where there was an infinite number of solutions, introducing the term ‘coincident lines’. She noted that in 3x3 matrices this extended to the various possibilities of the geometry of three planes, and although this was now going beyond the specifications of FP1 she thought it good to introduce students to the idea.

At the end of the session, the presenter reminded the participants of the resources on the Integral website, and asked participants to check they could access it reminding them they have such access for a year, free of charge. As such, she suggested they look at the website soon and download any resources they might want to use in future when they do teach FP1. She outlined what the participants would be doing next week, which would involve the link between matrices and geometrical transformations. She also noted that the sessions were recorded and that the participants would have access to the recordings after the sessions, and could download any of the
IWB slides, with or without, her notes added via the graphics tablet. She invited any questions, but there were none, with all participants giving a ‘smiley face’ and a ‘thank-you’ as they left the session.

Session 2
The same five participants were present as for Session 1. The presenter began by outlining what would be covered in this session, which was essentially the relationship between 2x2 matrices and transformation geometry in the (x,y) plane. For the latter she noted that the geometrical concepts of reflection, rotation and enlargement would be assumed prior knowledge for students. She introduced the topics with a trapezium, defined by four coordinates on the IWB, with the coordinates written in matrix form, and multiplied it by a matrix, to get a new set of coordinates. She asked what effect this ‘linear transformation’ would have on the trapezium, demonstrating with an image on the IWB that it had been rotated. She followed this by explaining and demonstrating that matrix multiplication moves a point (x,y) in the plane, to an ‘image’ point. She gave the participants an example to try themselves before doing it herself using the graphics tablet on the IWB. All were happy so she gave them a matrix, and asked them to find out what transformation it might represent, by experimenting with some points. She did this with several different matrices, asking the participants to decide what the matrices do in geometrical terms. Each participant had their own IWB to work on, but their results and conclusions could be shared, and the presenter brought them back together to discuss what they had found.

The presenter developed this further by introducing the two vectors (1 0) and (0 1) and how multiplying these by any 2x2 matrix will give information as to the transformation the matrix represents. She illustrated the idea on the IWB and then gave the participants several examples to try for themselves, before going through them on the IWB discussing what was happening geometrically. Examples included rotation about the origin through 90 degrees, reflection in the lines y=x and y=-x and enlargement. She pointed out the characteristic form of the 2x2 matrix for each of the three transformations. She then took rotation further, asking what would be the matrix for a rotation of 45 degrees about the origin. The participants used the (1 0) (0 1) vectors to come up with the result, which was then readily generally generalised to any angle.

The session moved on to the idea of reversing a transformation, with the presenter asking “how do we get back from the image to the original object?” reminding participants of the result
\[ A \times A^{-1} = I \] and \[ A^{-1} \times A = I \] from Session 1. She showed several examples of how the inverse matrix reverses a transformation, giving the participants several examples to work on themselves. She reminded participants of the determinant of a 2x2 matrix, and then showed a transformation of the unit square by a matrix and asked what the area of the image is. She demonstrated that this area has the same value as the determinant of the matrix, raising the question “is this always the case?” She gave the participants some examples to investigate and to confirm the result. She then raised the question “what if the determinant is zero?” She demonstrated that such a matrix collapsed a triangle onto a line giving the participants more examples to try, before summing up the result that a singular matrix has no inverse, its determinant is zero and a 2 dimensional shape is transformed onto a line and thus has zero area.

In starting to bring the session to a close, she introduced some related topics that participants might wish to pursue further. She mentioned compound transformations and asked if reflection in the y axis followed by a reflection in the line y=x, gave the same result if done the other way round; she used the vector (1 1) to demonstrate that it didn’t. She noted that the compound angle formulae
can be proved by using transformations, but didn’t pursue it further. She introduced the matrices for the transformations shear and stretching, giving the participants some examples to find out what transformations they represented. She also mentioned the concept of invariant points and lines. She gave the participants a ‘challenge’ to take away and also some typical examination questions.

Finally she noted there is a 3 dimensional equivalent to all these results and that there was some 3x3 matrix work on the Integral website.
Appendix C
Detailed report following observation of the event,
Preparing students for STEP / AEA Mathematics

Historical Perspective
The presenter started from the 1970s, noting that at the time sixth form students contemplating entry to Oxford or Cambridge would expect to stay for a third year in the sixth form, to take the entrance examinations. The concept of ‘3rd year 6th’ subsequently declined and the entrance scholarship papers were replaced by special papers, but there was an issue as regards university entrance of would candidates of the calibre sought after in mathematics have the experience and maturity to take entrance examinations at a younger age. In the 1990s whereas Cambridge opted for the sixth term for an examination, and thus STEP, Oxford looked for potential in a fourth term examination paper. The historical perspective was summarised on a PowerPoint slide.

In the STEP papers, Cambridge was no longer looking for students using mathematics beyond the normal A level syllabus, but would set questions of a more demanding nature on the A level syllabus itself. The intention was to let potential Cambridge entrants demonstrate their problem solving skills; the questions would stretch the gifted and talented students in mathematics in less structured questions requiring a synthesis of topics and techniques by the candidates.

Around the year 2000, special papers were replaced by the Advanced Extension Award, where a single examination board took responsibility for setting the paper. The presenter noted that, at least in principle, these papers were accessible to all gifted and talented students, not just those at “leading schools”. The presenter noted the response from Cambridge, and also Warwick University, was to put on a two day course for students who couldn’t get the level of support they needed to prepare for STEP papers in their own school. He said the atmosphere at these courses was very positive.

The problem-solving mindset
The presenter contrasted the STEP / AEA papers with what students meet on the modular A level specifications.

- The syllabus is the same; the questions are harder.
- STEP / AEA papers are 3 hours, as opposed to 90 minutes for a typical module paper.
- Questions on a modular paper are structured so as weaker candidates can enjoy some success; there is little or no structure in a STEP / AEA question.

The presenter noted that modular papers tended to be pedestrian, structured and technique based; there was little or no thinking time. So candidates preparing for STEP / AEA needed new strategies for a 3 hour paper, in which they were given little help and guidance within a question as to how to tackle it. Often, where or how to start a question was a major problem for students. The presenter highlighted to the delegates that students preparing for STEP / AEA need to think more deeply about the mathematics they have met and more rigorously than would be usual on the standard A level course and its assessment, noting that teachers need to be aware of this as well. Teachers need to provide appropriate experiences and support to student in tackling these types of questions.
He highlighted some STEP / AEA issues:

- There is a choice of questions; which ones to attempt?
- Stamina; how to keep going for 3 hours.
- Use of time; thinking time v doing time; and ‘going wrong’ and ‘putting it right’.
- Coping with being stuck; not panicking.
- Feeling insecure with little or no structure as guidance; not knowing if the chosen approach will work.

The presenter offered an analogy in rock climbing; if you get stuck you have to get out of it; doing nothing is not an option; don’t panic; think...laterally...and try something. If what you try doesn’t work; again don’t panic; it may generate new ideas, and lead to a strategy for a solution. The presenter summarised this problem-solving mindset approach on a PowerPoint slide for questions and discussion.

The presenter then outlined the structure of the STEP papers themselves noting further details are available on the Cambridge website. There are three papers; STEP I and STEP II which are based on the pure mathematics core of C1, C2, C3 and C4 together with the applications M1, S1 and D1 and STEP III being based on Further Mathematics modules. For STEP I and II, he noted there are 13 questions, of which a candidate’s best 6 answers will count towards their mark, and that a grade 1 pass, could be achieved through 4 good answers; ie answers in which a candidate had made substantial progress through a question. He noted that numbers entering STEP have been rising in recent years, and presented some figures in support of this.

He then presented some typical questions, again emphasising it is not obvious where to start, and some thinking time was needed and then invited suggestions, and developed these into partial solutions, noting how when working with students, the teacher needs to let the students take over the development of a solution.

In summing up this section on the problem-solving mindset he noted that STEP is compulsory for Cambridge entrance; Warwick will accept STEP or AEA, other universities, such as UCL and Nottingham say STEP or AEA is desirable but not essential, but it is clear it is preferable for entrants to have such a qualification. He noted that universities that require STEP or AEA or desire it, are providing resources and support to help candidates prepare for the examinations either through a face-to-face course or online support. He also noted that online support was available through websites such as Nrich. He again summarised the details on a PowerPoint slide, and suggested further discussion could take place during the coffee break.

**Hands on with problems**

The presenter started this session by raising the question, “when should the type of problem solving strategies required for STEP be introduced to students?” He suggested it should be during Key Stage 4. He noted that students need to adopt an attitude to mathematics and what they learn in class that doesn’t question “do we need to know this?”, but are motivated by the challenge of an original, demanding problem.
The presenter then invited the delegates to try some of the problems from their delegate’s pack. He invited them to work together, but most started to work on their own, before conferring. The evaluator noted there was a considerable range of types of problem in the pack. The presenter circulated answering questions and giving advice, but it was helpful hints, noting that is what students need to keep them progressing and not giving up. A good hour was given over to letting delegates discuss the problems and the issues regarding the problem-solving mindset that arose from them. The presenter ended the current session before lunch by noting that to inspire students, teachers need to be enthusiastic and committed and clearly interested in solving the problems themselves. The teacher needs to build a student’s confidence, not through a ‘recipe’ approach of ‘do this, now do this’, effectively solving a problem for them, but by encouraging the student to try things and reflect on the outcome; in short, help the student to work as a mathematician.

**Mini-lecture – extending a topic from A level Mathematics**

The presenter started this session by again emphasising the need to build up a student’s confidence to tackle the STEP style questions. He recommended starting with easier and more accessible questions at first, but emphasised that students need to think about the steps they are going through in order to get to an answer. He noted that problem solving is an acquired approach or style and that students need to realise it is quite acceptable, indeed desirable, to work together whilst developing the approach, noting that ability to communicate ideas and your thinking is an important aspect of developing an ability in problem-solving. He highlighted the teacher’s role as the collaborator, the encourager and the critic, but supporting a student and not being in competition with him or her. He noted that resources are needed to develop these traits in students noting that as well as the courses provided by some universities, the FMSP offers an online course; there are resources on the *Integral* website, and MEI and *Nrich* have forums to support STEP and AEA.

He then moved onto the challenging problem... we “know” $\pi$ is a never ending decimal ... but how do we know it never ends and doesn’t repeat?

The presenter noted that problems similar to this could readily be introduced to students in Key Stage 4, and how the ideas could then be extended at A level when students come across geometric progression. There was a lot of discussion about what could be discussed with students at various stages in their learning, suggesting for example that the proof that $\sqrt{2}$ is an irrational number, should be within the scope of bright Key Stage 4 students, but to prove $\pi$ is irrational should be left for discussion in a STEP session.

The presenter left this problem for delegates to go away and think about, and presented a contrasting problem from geometry, again around the notion of proof and necessary and sufficient conditions. This also brought up the idea of proof by contradiction. In summarising this last session, the presenter again noted how the notion of proof can be introduced in Key Stage 4, laying foundations for further extension later, for those students who aspire to read mathematics at the universities who ask to enter for STEP and/or AEA qualifications.

At the end of the session the local Area Coordinator asked the delegates to complete an exit evaluation form, before leaving.
Conclusion
The evaluator certainly found the presenter to be well prepared, although felt at times there was too much detail on the PowerPoint slides. The presenter had carefully brought out the needs of a student who wishes to take STEP or AEA papers, as opposed to what is required on a standard A level. The evaluator thought that delegates would go away with a good understanding of what is required, ideas for implementing it in their own school or college and ideas for resources to support that. Delegates had clearly enjoyed working on the problems in the delegates’ pack themselves, and through doing so had ideas to take way on how these could be used effectively with their own students.
Appendix D
Detailed report on the professional development event Extension and Enrichment at Key Stage 4

Day 1

The session was hosted by the local Area Coordinator, who welcomed delegates and introduced the two presenters from the FMSP. There were twenty delegates present.

One of the presenters gave an outline of the course and structure of the Day and also of Day 2 that would follow in a few weeks’ time. She highlighted the principal aim of the event was to enable delegates to enthuse the more able Key Stage 4 students about mathematics so that they might consider taking A level Mathematics. She told the teachers that they would meet a variety of resources and engage in a variety of activities, that they could take back to their school, and try with the target students. In Day 2, the teachers would report back and discuss their experiences.

In introducing the first activity, the presenter asked the delegates to work in pairs or threes and to interact with each other and discuss what they were doing and to think about how they might use the activity in the classroom. She asked them to make notes for sharing later, and she highlighted that all the activities were designed to be flexible, so teachers could think about how they might adapt them. The presenter also noted that copies of all the activities were available through the Integral website. She noted the FMSP did monitor use of the different activities from the website.

The activity involved a card sort on indices and related topics and the presenter pointed out that matches might be twos or threes, or some may not match. She noted that the teacher notes were deliberately brief, but included suggestions on use of the activity, advice on student responses and the answers. Before starting the activity she asked the delegates to think about student misconceptions, and links between different representations of the mathematics involved.

Delegates worked with the activity for about 20 minutes. All were engaged with the activity and considerable discussion took place.

In introducing the first activity, the presenter asked the delegates to work in pairs or threes and to interact with each other and discuss what they were doing and to think about how they might use the activity in the classroom. She asked them to make notes for sharing later, and she highlighted that all the activities were designed to be flexible, so teachers could think about how they might adapt them. The presenter also noted that copies of all the activities were available through the Integral website. She noted the FMSP did monitor use of the different activities from the website.

The activity involved a card sort on indices and related topics and the presenter pointed out that matches might be twos or threes, or some may not match. She noted that the teacher notes were deliberately brief, but included suggestions on use of the activity, advice on student responses and the answers. Before starting the activity she asked the delegates to think about student misconceptions, and links between different representations of the mathematics involved.

Delegates worked with the activity for about 20 minutes. All were engaged with the activity and considerable discussion took place.

The presenter moved onto a second activity. This involved a game based on noughts and crosses but using algebraic expressions. She suggested in class it might be organised as a competition between two teams of students, with the ‘board’ displayed on a whiteboard. She suggested students could be encouraged to think about strategies, trying to win as opposed to preventing the other team from winning. She suggested there might be a forfeit if a student made a mistake. She suggested as an activity in class it might be 20 minutes in which students would develop their understanding of the equivalence of algebraic expressions.

The other presenter then introduced a third activity, this one involving algebra and geometry, focusing on Pythagoras’ Theorem, circle theorems and trigonometry and how they might be involved in solving the problem posed. Ruler and compass constructions could be used. The delegates worked on the problem whilst the presenters circulated giving help and advice. It was noted it was important to give students hints to help them move in a positive direction, but not to show them ‘how to do it’.

Following in this activity, the presenter led a discussion on reflecting on how the activities the delegates had worked on, could be used to develop the Higher Tier GCSE topics of quadratics,
completion of the square, roots and indices, surds and Euclidean algebra. He asked the delegates to think about when in a lesson an activity would be appropriate, and whether it should be a whole class activity, in groups or just for an individual student.

He asked the delegates to write down any thoughts, bright ideas or concerns they were having on post-it-notes, and paste them on the wall for sharing. He then invited feedback from the delegates on their experiences with the activities, which they willingly did. The presenter noted again the need for flexibility and that the needs of the most able students would differ from those that were struggling.

Before the break, the presenter again explained the structure of the two days, relating this to the DfE funding of the course. Day 1 was to experience doing some activities, then to go away and try them out at school adapting them as required and then to report back on Day 2 on their experiences and what had been learnt. Day 2 would also focus on issues concerning embedding the problem solving approach into classroom practice in delegates’ own schools. It was noted that 400 teachers were taking part in this course across England and that the DfE insisted on there being teacher feedback and that pro-formas were provided to guide this. The presenter also noted how they were hoping to set up support networks between the participating teachers. The delegates were asked to complete a pro-forma on how they had found the activities they had experienced and discuss their thoughts with each other. In particular, the presenter highlighted the importance of identifying what students will get out of engaging in a particular activity, a skills analysis, and that this would be a requirement in a school inspection.

The next session involved discussing the issues and challenges in ensuring appropriate provision for the more able Key Stage 4 students in the classroom. The presenter noted this relates to how GCSE might develop in the next few years. The delegates were given some printed quotations from recent, and not so recent, publications and asked to put them in order from the most pressing to the least pressing concern. They again worked in their groups to do this in discussion with each other. The two presenters circulated, getting involved in the discussion and getting the delegates to think about the issues involved. The teachers clearly valued this opportunity to discuss these issues from similarly interested and motivated colleagues from different schools. The presenters did ask the delegates to think about the issues and how they related to the circumstances in their own school, and what for them were they most concerned about in classroom practice. Further, he asked how a discussion such as this might take place with colleagues in their school, and how this might convince other teachers and senior managers that there was an issue to be addressed. The presenter noted that the DfE want to move on from an examination based culture, and wants to encourage Key Stage 4 students into ‘doing mathematics’. They want to motivate an interest in the subject that will lead to students taking A level mathematics and more so continuing into higher education courses where they will use their mathematics skills and knowledge, whilst developing it further. The teachers were certainly happy to be engaged in such discussions, it being noted that they have little time in school to be reflective and have little opportunity to discuss issues such as these.

However, the presenter brought the group discussions to a close, asking the delegates in a plenary session for feedback on the issue of extension and enrichment versus performance and achievement, and how this can create tension within a school, particularly with the senior management. It was noted that future developments in the National Curriculum were largely
unknown, but there would likely be a move away from predictable examinations and teaching to the text.

The delegates were left with a lot to think about following these discussions. As a contrast before lunch, the presenters gave some instruction on how to access the extension and enrichment material on the *Integral* website, and again noted there was a forum there for this group of delegates to exchange ideas and views. It was also noted that there is also information on the website on AQA’s Level 2 Certificate in Further Mathematics for those who are registered with AQA.

After lunch, in session 3, the delegates were given another activity to work on. This was geometrical in nature and involved the diagonals of a dodecahedron. Questions were identified that might be raised with students, such as what is a diagonal, how many different diagonals are there and can we find all their lengths? This is a relatively difficult problem, but the delegates worked at it in their groups. The question was raised ‘what if students get stuck?’, and there was a discussion on minimal hints to keep them progressing. There was the related question of how much, if any, pre-task discussion should there be in class? It was noted there could be several approaches to the problem, so it was best to let students offer suggestions, and let them decide how they want to approach the problem. Teachers needed to appreciate there wasn’t a ‘right way’ to do it. The presenter asked the delegates after they had spent some time working on the problem to reflect on what they had been doing, what were their thought processes and emotions, did they feel stress before perhaps being elated by a breakthrough? One delegate noted that the problem can be solved using advanced trigonometry and wondered if this was ‘allowed’. The presenter advised that it would be your decision as regards your students. It was emphasised again that teachers need to think about the level of support and help offered to their students.

In the next session, the delegates were shown some other sources of resources that they might use. These included ‘Nrich’; ‘STEM Nrich’, United Kingdom Mathematics Trust (UKMT) and problem solving activities from the FMSP website. The delegates were invited to spend about 30 minutes looking at examples of activities from these sites.

The last session of Day 1 was a plenary session in which delegates were asked to think about planning for ‘the gap’; the time between now and Day 2. They were asked to think about what will work for them, how should they use the materials they had been shown or should they try new material? Also, which students should they target; just the very able and so stretch them, or an able group of students or a whole class, and how might this approach be adapted for lower ability students? It was noted however, that the pro-forma the delegates were asked to complete had as focus the more able Key Stage 4 students. In the pro-forma, the delegates were asked to review their current situation at school, and to identify their aspirations and any issues involved. They were asked to make decisions about which activities to try with their students and to bring feedback on their experience and the students’ response to Day 2. They were also asked to think about longer term plans. Discussion continued amongst the delegates whilst they completed this task. Before departing, the delegates were given another pro-forma on which to record the activities they would try in ‘the gap’ and to record the students’ responses.
Day 2  Four months later

Unfortunately, due to examination commitments at their school, 9 of the original 20 delegates were unable to be present. A separate Day 2 would be organised for them.

Day 2 was introduced by the presenters as an opportunity for the delegates to share their experiences and learn from each other. This was organised through ‘triad discussions’ with the delegates working in groups of three. One of the presenters would act as a 12th delegate. It was explained that the original grouping was random, but there would be three rounds and delegates would change groups between rounds.

In each round, each delegate had three minutes to describe what they had done, the response from their students and impact on them and any amendments they might make for next time. This was followed by three minutes of questions from the other two, and then three minutes of more general discussion. So each delegate, got to present their experiences three times over, but to a different two other delegates each time. The delegates were observed to participate willingly following the guidance given, and the presenter kept rigidly to the time allowance. The delegates were taking notes during the discussions using the pro-forma supplied. This ‘triad discussion’ did seem somewhat repetitive but the delegates were able to share their experiences and views with a range of others with the opportunity to get fresh perspectives at each change over.

After the three rounds the presenter asked the delegates to work in groups and to consider what makes for an effective teaching and learning strategy, how do you know it is effective, and what are the emerging issues and challenges in extension and enrichment work with Key Stage 4 students; for example is there a gender issue; are boys more responsive than girls to these sort of activities?

In a feedback plenary session, some of the answers to these questions were summarised. An effective strategy sees all students actively engaged with no one sitting and just listening. The activity is not seen as a ‘bolt on’; all students take part willingly and make some progress with the task. Teachers need to be aware of issues like the possible gender issue, a difference between Year 10 and Year 11 students, and between sets 1 and 2. Teachers need to have considered in their preparation, whether the activity is developing mathematics topics already met, or is introducing a new topic. It was also noted teachers could have ‘challenge material’ available to give to students who might finish a routine exercise ‘early’.

The presenter highlighted that it is important that students don’t just see the activity as a ‘bolt on’ piece of fun. ‘Selling’ this approach to students is important. They need to understand that through problem solving activities they will gain knowledge and develop skills that will help them progress to study advanced mathematics. The presenter also raised the question of how should a teacher form groups of students; mixed gender and/or mixed ability noting it was important that all students in a class benefited from the activity and that ‘one-to-one peer tutoring’ could be effective for both students involved. It was also noted that teachers should encourage students to raise questions, but also encourage them to answer their own questions; teachers should ‘withhold the answers’ and help students to progress through responding to questions with some guidance or posing a question to the student.

In the next session, session 7, the delegates were asked to consider problems in a realistic context and mathematical modelling. The presenter noted that such problems can vary in length from short
to extended. She noted that in the first instance students should only work with the information they are given, with no research, such as using the internet, allowed. However, students should identify what other information they needed to solve a problem, and whether this could be estimated.

One of the presenters handed out some examples of modelling problems. He asked the delegates to consider what mathematics was involved in solving the problem, and what do you need to know and what you can you estimate in order to make progress? Delegates were invited to work on a problem and discuss the mathematics involved. He then asked the delegates to think about what makes these problems difficult; it was noted it is not the mathematics involved but the modelling cycle, noting this is ‘out of the norm’ of a conventional mathematics lesson. Students will probably be uncomfortable in making assumptions that they may have to amend. He offered some examples; how big is a tree; how big is a dot? He then gave the delegates another problem, based on the fire and rescue service and the availability of water from a pond, raising the questions, what shape is a pond; how do we measure the depth and estimate the volume of water? In working on the problem, delegates were asked to think about the assumptions and decisions they needed to make and the issues that this might lead to if this was a class activity.

The presenter noted that some students might not see any relevance in the fire and rescue problem, so it is important to look for problems that are likely to be relevant to students and that they will find interesting; he suggested how many times does your heart beat in your lifetime? He noted there were ideas available through several websites and gave some suggestions and examples of problems from some of them. The presenter also noted that many students will not be comfortable with there not being a ‘right answer’. He emphasised the importance of letting the students use their mathematics and how it might give insight into a problem.

He gave one more example that he thought would interest students as it was based on an event from the television programme *Top Gear*. He asked which mode of transport would get between two places in London the fastest; a bike, a car, a boat or public transport? He noted that the ‘winner’ very much depended on the two places concerned and the assumptions made.

In the session following lunch, one of the presenters asked the delegates to discuss the question, what makes for a good CPD course; what are the factors that make CPD effective? The delegates discussed these questions in their small groups, before giving feedback in a plenary session. Some of the factors the delegates mentioned are:

- ideas to try out in the classroom / something you can use
- hands on experience / doing some mathematics yourself
- time for thinking how to use ideas and resources / not a bombardment of resources which are likely not to be used
- accountability / teachers should get something useful from a CPD course
- time for discussion with other teachers / sharing ideas
- sharing good practice and having ready to use resources
- being able to disseminate information and ideas and share resources back at school, so that colleagues feel included
- an open minded atmosphere / feeling confident you can say what you feel
- a clear focus
The presenter then asked the delegates to focus on dissemination and how they would share their experience of this extension and enrichment course with their colleagues. The presenters acknowledged that in school, time is limited, but she emphasised that 10 minutes in a departmental meeting will not be effective. She circulated the NCETM recommendations for effective CPD.

She cited another publication that contrasted telling others what to do as opposed to ‘selling it’ to them by explaining why this initiative is needed and that support is available whilst colleagues try out some ideas and develop some of their own. The teachers were then asked to use a pro-forma to help them think about how they will disseminate their experiences with colleagues at school, and embed extension and enrichment activities into their schemes of work. Teachers were asked to write something on each of the questions, what do I want to achieve, what issues and challenges might arise, what will be an effective approach and how will I know I am achieving my objectives? It was noted that the presenters were not telling the delegates how dissemination should occur; rather they were asking the delegates to decide what would be best for them with their colleagues in their own school.

In the final session of the course the presenter asked the delegates to contribute to a ‘resources wish list’. What sort of materials do they want; what types of activity and covering which topics in mathematics? The presenter noted that although she was wanting an immediate response, delegates could post ideas and requests on the forum via the website at any time. She asked the delegates to discuss the question in their groups for about 15 minutes and to ‘write up their requests’ and let her have them. She noted that MEI will employ someone to develop the requests and ideas put forward.

In closing, the presenter reminded the delegates of the extension and enrichment material on the Integral website, and that they had access to this up to August 2014; she encouraged them to use it. Finally she asked the delegates to complete the FMSP exit evaluation questionnaire on how they had found the course.
Appendix E
Detailed report following observations of LIL FM sessions

The evaluator observed the recordings of two live sessions, both on the topic of complex numbers. The first of these was the very first session in a series of lectures on FP1 (Further Pure Mathematics 1) and the second session was a lecture midway through a series of lectures on FP2, for a different examination board.

The presenter for the FP1 session gave a welcoming introduction to herself and the 19 students who had already logged in. There were a few latecomers, so that later in the session there were 25 students participating. The presenter started by making sure the participants could hear her, and explained how to adjust the audio equipment if necessary. She demonstrated the facilities of the virtual classroom, and invited the students to try them for themselves. She encouraged use of the ‘smiley face’ to let her know they were ‘happy’ and to use the ‘chat box’ in answering or asking questions. It was notable that throughout the lecture, no student opted to use the microphone, but some did use the ‘hand up’ facility to draw the presenter’s attention to a question.

The presenter outlined what she would cover in the lecture in this introduction to complex numbers, when one student interrupted to say she was expecting matrices. Others confirmed this saying that is what they had come prepared for. The presenter dealt with this unfortunate situation calmly and professionally, saying she would switch to matrices if that is what students wanted, or she could continue with complex numbers. A vote was held, which was an opportune way of making sure all students could use the virtual classroom voting facility. The consensus was to continue with the complex numbers, but many asked via the ‘chat box’ for the presenter to take it slowly, a request she responded to.

The presenter’s exposition in introducing the need for complex numbers so that any quadratic equation could be solved, was very clear; she made use of pre-prepared IWB (Interactive Whiteboard) slides as well as using the graphics tablet for ‘live’ demonstrations of results and solutions of problems. For each of the various topics, she had a reference to exercise questions highlighted on the IWB, so that students could use these from their textbook subsequent to the lecture. In her lecture, the presenter continually involved the students asking for suggested answers to questions via the ‘chat box’, or to vote for an answer through the multiple choice voting facility in the software. This worked well in that the majority of students voted for the right answer and the presenter congratulated them, although the evaluator noted that not all the students had voted. The presenter did however ask continually if everyone was ‘happy’ and would go back if all were not but this does depend on students responding. The evaluator noted that there is a limitation in the virtual classroom in that the presenter cannot pick up visual signals from the students indicating non-understanding that might be responded to in a conventional face-to-face lesson. Towards the end of the lecture, the presenter did leave some problems unfinished, but emphasised to the students that they should return to the problem and consult their teacher if they needed help in completing it. The presenter realised she was over running her time, and thanked the students for their patience and congratulated them for staying with the lecture. She ended with a summary of what they should have learnt during the lecture, and gave details of the next three sessions, noting that she would clarify the schedule with MEI and ensure all students had the updated version.
The students did seem to go away ‘happy’ as there were a lot of ‘smiley faces’ and no further questions although after an hour long lecture it is difficult to conclude anything from this. The evaluator hoped that teachers would follow the LIL FM intention, and follow up the ideas presented with some review work in class.

The second session on FP2 was in quite some contrast, there being only three participating students. Although this session began with the presenter saying it would focus on the roots of unity and generalise to roots of complex numbers in general using De Moivre’s theorem, the lecture seemed to move swiftly into a mechanics problem and solving a differential equation, which was somewhat confusing for the evaluator! It seemed to transpire that these three students were taking the same Further Mathematics modules, and so this flexible catch up, from a previous mechanics lecture was quite acceptable to them. It was notable that this could only be possible if the students were taking the same modules, which only seems likely if there are small numbers.

Having sorted out the mechanics problem to the students’ satisfaction, the presenter then introduced the roots of unity and how they lie symmetrically around a circle, before moving into how this concept could be generalised. Again the students used the ‘chat box’, rather than the microphone to respond to the presenter’s questions or ask their own there being rather more of the former. This presenter also used a mix of prepared IWB slides and ‘live’ demonstrations of solutions on the graphics tablets, inviting input from the students. After going through the required knowledge and techniques, he gave the students lots of examples to work on, and guided them through the solutions.

It was notable at the end of this session, that the presenter negotiated with the students when the next FP2 and M2 sessions would be, confirming the flexibility of the arrangements and indeed the cooperative rapport he had built up with them.

---

11 This small group of students received LIL support for a number of modules from the same tutor. In this situation it is possible to be more flexible with the timetable and take queries from the students about the other work they have been doing at any point. This is encouraged by the FMSP in this situation.
Appendix F
Case studies of establishments that offer Further Mathematics

Category 1  Sixth Form College with a large entry
The college has offered Further Mathematics since it was opened, and for many years has had sufficient students to warrant separate sets for A level Further Mathematics students, which are fully timetabled. All the teaching is done by the college staff, who are well qualified to do so.

College staff first came across the FMSP through a professional development event and they have developed good relationships with the Area Coordinator. Subsequent events that staff have attended were described as good and relevant and helpful in developing their teaching. They make use of resources from the Integral website. Students are informed of revision events and the online facility although it was thought take-up wasn’t large. They offer little by way of enrichment to students and do not take part in the Team Challenge.

Further Mathematics is brought to the attention of Key Stage 4 students through college open evenings. They have not had any problems in attracting students to take Further Mathematics although there is some concern that imminent changes in A level to linear courses may impact on this, if it reduces A level subject choice to three subjects.

Category 2  Sixth Form College with 2012 entry of about 20
The college has offered A level Further Mathematics since it was opened, and introduced the AS level five years ago. They do all their own teaching. They have a Further Mathematics group, who cover the main A level core in Year 12 and then study the Further Mathematics in Year 13. They are timetabled 9 hours a week for mathematics. Some students on the main A level, take up AS Further Mathematics in Year 13 as well. They enter a team into the Team Challenge, saying students enjoy it, but do no other enrichment activities.

The department came across the FMSP through a professional development event, but have little contact with their Area Coordinator. However, they have been to subsequent professional development events, which were described as informative with useful resources made available. They promote Further Mathematics to Key Stage 4 students through open evenings and sample lessons at induction, but they are satisfied with their current numbers. It was noted that some talented mathematicians do not take Further Mathematics if they wish to study medicine in higher education. This college too is concerned about the potential loss of flexibility if changes are made to A levels, and this may impact on numbers.

Category 2  Sixth Form Centre / part of a consortium with a 2012 entry of about 40
The centre has offered both A and AS level Further Mathematics for many years. The Further Mathematics students are taught in separate groups of about 20 students, by the Centre’s own staff on a full timetable. The Centre became aware of the FMSP through internet browsing, and one teacher took an online professional development course, described as great and informative. Teachers from the Centre would like to attend a local face-to-face professional development event.

Some students attended a maths inspiration enrichment event which they enjoyed and the Centre enters the Team Challenge, which was said to be brilliant. They bring the revision events to students’ attention but would like earlier notice of these. The Centre doesn’t do anything in particular to promote Further Mathematics to Key Stage 4 students but their numbers have been
steadily growing. There is a concern for students that taking Further Mathematics may limit other options, but they do continue to attract good students to the subject.

**Category 3  Grammar School – typically 10 to 15 students take the full A level in Further Mathematics**

Further Mathematics is well established in the school and has been offered for many years. All the mathematics teaching staff can teach at this level. Students taking Further Mathematics are taught mathematics in a separate group and take A level Mathematics and Further Mathematics over two years. Main course students can opt to take the AS level in Year 13; the school finds this difficult to staff, but students can take the course through the FMSP online lectures (LIL) with staff support.

Teachers at the school met the Area Coordinator through the Team Challenge and developed a good working relationship. The AC was described as helpful and responsive and, for example, has organised professional development for the staff and some students have used the online support available through the FMSP. For example some teachers attended the STEP problem solving course, and found it ‘brilliant’. However, the school mostly works on a networking basis with other grammar schools in the area.

The school organises its own enrichment activities from Year 7 onwards, including competitions, but they enter teams for both the Year 10 and Senior Team Challenge, and said the students involved enjoyed taking part.

Key Stage 4 students are made aware of Further Mathematics from Year 10 onwards, but the school has a good reputation and attracts students from other schools to take Further Mathematics in the sixth form. Some sixth form students are felt to have the ability to take Further Mathematics but for many, this would be a fifth A level, and the work load would be too high. The school think numbers are unlikely to grow but would be content with about 20 students taking the full A level, but would like to do more to support those who opt for the AS level Further Mathematics in Year 13. They would also like to see more girls taking Further Mathematics and hope having female role models on the staff will help this. The school believes that taking Further Mathematics boosts a student’s core mathematics grade.

**Category 3  Further Education College – typically 10 to 12 students**

The College has always offered Further Mathematics and it is taught by their own staff. The students are taught as one group and study both A level Mathematics and Further Mathematics over two years on a full timetable. The College came across the FMSP through a networking event, but have had no involvement with the local AC. They have however, attended some professional development events, which they found very helpful and liked the resources provided.

Further Mathematics as an A level option is brought to the attention of Key Stage 4 students both through open evenings and also College staff visit the local schools. Students at the schools are offered taster sessions. It was noted that the number of students taking the full A level tends to remain fairly constant, but there is a growing interest in the AS level in Further Mathematics; it was also noted that some students who could probably take the full A level just want to take the AS level. The College believes that through taking Further Mathematics, students develop a better understanding of mathematics and they gain a better grade in the main course as a result. Students make use of the online revision sessions.
For enrichment, they let students know about events, but the only organised event is the Team Challenge, which they enter and students have found stimulating.

**Category 3  Sixth Form College – typically 10 to 15 students**

The college has offered Further Mathematics since it opened. The teaching is shared amongst five members of staff. Some staff are very experienced whilst newer members have undertaken professional development which they found to be very helpful with useful resources made available. The Further Mathematics students are taught in their own class, and it was noted there is usually a good working relationship in the class, with students supporting each other. One member of staff attended the STEP event, as they have students who take the STEP examinations.

The College was involved with the Further Mathematics Network from when it first formed in 2004, and they are involved in local networks. The staff have little personal contact with their AC but there is frequent contact via email and invitation to events, and the working relationship was said to be very good.

The College puts on taster days for potential students of A level Mathematics and Further Mathematics, and also has a mentor arrangement in which current students go into the local feeder schools to talk to prospective students and take part in lessons. The Further Mathematics students also hold support workshops for those students on the main A level mathematics course. The College will allow any student who wishes to take Further Mathematics to do so and they usually start with up to 20 students, but some of these will drop back to AS level although the mutual support amongst the students does encourage weaker students to stay on the full A level course. Other main course students may take up Further Mathematics in Year 13. The online revision sessions are brought to students’ attention, and some students ask to use the recordings. The College takes its mathematics students to enrichments events, such as *let maths take you further*, and they enter for the Team Challenge. The students also enjoy the games and quizzes they find on the Integral website and both staff and students make extensive use of the other resources available on this site. The College in fact would like to see more interactive ‘fun-stuff’ on the site, which none the less stretches and challenges the students and can stimulate lively classroom debate. However, the Integral resources were summed up as ‘being fantastic’.

**Category 4  Comprehensive School - had 4 students in 2012**

The school has been offering Further Mathematics for many years, but they only have small numbers of students and none in some years. It is taught by their own staff who have the appropriate experience. Students taking Further Mathematics are taught alongside those taking the main A level course in Year 12, but form a separate group in Year 13. They get 7 hours tuition over two weeks.

The school became aware of the FMSP through attending an FMSP event, but they have had little contact with the AC. They have however made use of online professional development and use the Integral website resources. Key Stage 4 students are made aware of Further Mathematics through the ‘next step’ evening for Year 11 students. They are hoping that more students will take up Further Mathematics but note the need to improve results at GCSE before this is likely. However, it is believed that students who take Further Mathematics get a better main course grade as a result and students are encouraged to use the FMSP online revision resources.
The school organises its own in school enrichment activities but takes part in the Year 10 and Senior Team challenges.

**Category 4 Comprehensive school – 9 students in 2012 having grown from 1 in 2009**

The school first offered AS level Further Mathematics in 2008/09 and it was taught through FMSP tutors to begin with. The school became aware of the FMSP through direct contact by the AC, who has continued to offer support and advice, for which the school is grateful. The role of the tutors in developing Further Mathematics in the school was also much appreciated.

Currently they are teaching Further Mathematics themselves for the first time, without any input from FMSP tutors. Staff have attended FMSP professional development courses to enable them to do this. These were said to be excellent. The school has two sets of A level Mathematics students and the Further Mathematics students are taught together in one of these, but they also get some tuition and support time on their own. Year 2 students are currently on a reduced timetable but the school hopes this will move to a full timetable next year; the AS level course is currently fully timetabled.

There is a whole school programme for Key Stage 4 students on post-16 opportunities but the department also offers taster lessons for those considering A level Mathematics. They also encourage strong A level students to take up Further Mathematics as well. They hope the number of students taking Further Mathematics will grow, but note the limited staff capacity to teach it. However, they note students often require a broad range of subjects for university entry and Further Mathematics might not be a requirement. The school believes that students taking Further Mathematics boosts both their own grade in the main course and influences others just on the main course to do well. They are currently working with their AC on preparing students for STEP examinations. The school currently has no enrichment opportunities for Key Stage 4 or A level students.

**Category 4 Further Education College – 6 students in 2012 rising from 2 in 2009**

The College has offered Further Mathematics for many years. The Further Mathematics students are taught alongside those on the main A level course, and this was said to work very well. They do all the teaching themselves but make use of the resources on the Integral website. They came across the FMSP through the MEI website and decided to register. There has been little face-to-face contact with the AC, but there is regular exchange of emails and staff have been to a variety of professional development events. They value having support and advice available as needed.

The college doesn’t do anything in particular to encourage Key Stage 4 students as the numbers applying for AS level Further Mathematics usually exceeds 20. It was felt that interest had increased through some local schools offering the level 2 Further Mathematics course (AQA) although there is concern that the schools are dropping this due to changes in GCSE. However, students whose algebra is felt to be weak are encouraged not to take Further Mathematics, and similarly those taking mathematics and three science A levels, are advised that taking Further Mathematics would be too heavy a work load. However, it was noted that Year 13 A level Mathematics students can take up the AS level then if they wish to. The college felt that students taking Further Mathematics obtained a better grade in the main course as a result. Students are encouraged to make use of the FMSP online revision facilities.
The students have been to some enrichment events, which they have enjoyed, and they have taken part in the Senior Team challenge.

Category 5  Comprehensive school – 2 students in 2012
Further Mathematics has been running at the school since 2005. Two members of staff teach it, and the full A level has been allowed to run fully timetabled despite the small numbers. It was noted main course students can take up the AS level course in Year 13. First contact with the FMSP was made through an email enquiry about resources. They now make extensive use of the resources on the Integral website. There has been little contact with the AC, and they tend to network with local teachers and they are also part of an academy chain. However, some teachers have been to professional development events which they found good; the school has some newly qualified graduate teachers and is keen to develop them so that they can teach Further Mathematics.

Further Mathematics is brought to the attention of Key Stage 4 pupils through talks by the Head of Department to Year 11 students. Students at the end of Year 12 on the main course are also offered taster sessions on taking AS level Further Mathematics. Those who see a need for this, such as taking a ‘STEM’ degree course will often take up the opportunity. Students who might have taken the full A level often don’t, because Further Mathematics would have been their fifth A level and the work load would be too high. However, the school would like the number of students to increase, but see it as unlikely they will exceed 10.

Students are made aware of enrichment and revision events, but it was noted the school is quite distant from the usual venues, and students tend not to go, although they do take part in the Senior Team challenge. Similarly students are advised of the online revision sessions, and can use them if they wish to. The school values the support of the FMSP and wants to stay informed of events.

Category 5  Grammar school for girls; mixed sixth form – 3 students in 2012
Further Mathematics has been offered for many years. They now do their own teaching and have three members of staff who can teach at this level, who share the classes. The Further Mathematics students are taught in a separate group, and timetabled time has increased from 4 to 7 hours a fortnight over two years. The school has been involved with the FMSP for several years. The school has connections with the local university where the AC is based and was also involved with the Further Mathematics Network. They continue to attend networking events and also have staff who have undertaken professional development; two teachers recently took the TAM course, which was described as a great course. This teacher didn’t mention the Integral website, but she did say there was a need for more resources, particularly to help develop students’ understanding of the mathematics of FP2.

Key Stage 4 students are introduced to Further Mathematics in Year 10 and 11 through taster sessions and are given some detailed information on what A level Mathematics and Further Mathematics involves. The school hopes that some of these will take up Further Mathematics and that the numbers will grow. The barrier to growth in recent years is seen as the limited teaching time that has been available leading to results that weren’t as good as they might have been. They are hoping for better results with the increased timetable time they now have, and as such that it will attract more students. It was noted that although typically 10 to 15 students start the AS level course in Year 12, the drop out is quite high, and for many of these students Further Mathematics was their fourth A level. However, both students and staff have attended FMSP revision events,
which were found to be very useful. Staff and students have also been to some enrichment events, such as ‘let maths take you further’, and they take part in the Senior Team challenge.
Table 5.3: Mean cohort size and student achievement of establishments with 10 or more entries in A level Further Mathematics at least once during subsequent years after year of first entry up to 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>FM establishments</th>
<th>FM students</th>
<th>FM UCAS AM</th>
<th>AM students</th>
<th>AM UCAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>2003</td>
<td>0</td>
<td>17.9</td>
<td>84.0</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>2004</td>
<td>0</td>
<td>18.1</td>
<td>89.9</td>
<td>2.4</td>
</tr>
<tr>
<td>2005</td>
<td>2005</td>
<td>2.4</td>
<td>101.2</td>
<td>22.7</td>
<td>90.2</td>
</tr>
<tr>
<td>2006</td>
<td>2006</td>
<td>2.8</td>
<td>93.8</td>
<td>24.6</td>
<td>90.2</td>
</tr>
<tr>
<td>2007</td>
<td>2007</td>
<td>4.5</td>
<td>94.3</td>
<td>30.7</td>
<td>93.7</td>
</tr>
<tr>
<td>2008</td>
<td>2008</td>
<td>0</td>
<td>21.2</td>
<td>86.6</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>2009</td>
<td>0</td>
<td>26.0</td>
<td>91.4</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>2010</td>
<td>0</td>
<td>28.6</td>
<td>92.2</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>2011</td>
<td>0</td>
<td>29.2</td>
<td>86.0</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>2012</td>
<td>0</td>
<td>30.2</td>
<td>93.6</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 5.3 continued

<table>
<thead>
<tr>
<th>Year</th>
<th>FM Students</th>
<th>FM UCAS</th>
<th>AM Students</th>
<th>AM UCAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>14</td>
<td>6.1</td>
<td>97.2</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97.7</td>
<td>7.5</td>
<td>99.6</td>
</tr>
<tr>
<td>2006</td>
<td>19</td>
<td>4.6</td>
<td>101.4</td>
<td>38.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.1</td>
<td>102.7</td>
<td>49.5</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>2.4</td>
<td>108.3</td>
<td>38.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.6</td>
<td>106.4</td>
<td>44.0</td>
</tr>
<tr>
<td>2008</td>
<td>5</td>
<td>4.0</td>
<td>104.0</td>
<td>30.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0</td>
<td>106.4</td>
<td>40.4</td>
</tr>
<tr>
<td>2009</td>
<td>2</td>
<td>0.0</td>
<td>35.0</td>
<td>92.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>100.0</td>
<td>37.0</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>0.0</td>
<td>34.5</td>
<td>90.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0</td>
<td>40.0</td>
<td>89.8</td>
</tr>
</tbody>
</table>
Table 5.4 Mean cohort size and student achievement of establishments with 4 or more entries, but less than 10, in A level Further Mathematics at least once during subsequent years after year of first entry up to 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>FM establishments</th>
<th>Mean</th>
<th>SD</th>
<th>AM establishments</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.5 Data analysis of the impact of introducing Further Mathematics Support Programme Phase 4

<table>
<thead>
<tr>
<th>Year</th>
<th>No Further Mathematics Establishments</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 5.5 (continued)

Data analysis of the impact of introducing Further Mathematics

<table>
<thead>
<tr>
<th>Year</th>
<th>FM students</th>
<th>FM UCAS</th>
<th>AM students</th>
<th>AM UCAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>42</td>
<td>2.5</td>
<td>99.6</td>
<td>22.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.9</td>
<td>15.2</td>
<td>13.3</td>
</tr>
<tr>
<td>2006</td>
<td>54</td>
<td>2.4</td>
<td>95.8</td>
<td>16.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.3</td>
<td>15.7</td>
<td>8.6</td>
</tr>
<tr>
<td>2007</td>
<td>45</td>
<td>1.9</td>
<td>99.8</td>
<td>19.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2</td>
<td>16.1</td>
<td>12.4</td>
</tr>
<tr>
<td>2008</td>
<td>36</td>
<td>2.4</td>
<td>99.1</td>
<td>21.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.6</td>
<td>16.5</td>
<td>10.9</td>
</tr>
<tr>
<td>2009</td>
<td>22</td>
<td>0</td>
<td>14.3</td>
<td>91.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.6</td>
<td>9.2</td>
<td>1.8</td>
</tr>
<tr>
<td>2010</td>
<td>14</td>
<td>0</td>
<td>15.6</td>
<td>83.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.0</td>
<td>12.3</td>
<td>9.2</td>
</tr>
<tr>
<td>No FM</td>
<td>112</td>
<td>7.5</td>
<td>75.8</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.1</td>
<td>15.1</td>
<td>6.0</td>
</tr>
</tbody>
</table>
### Table 5.5 Change in cohort size and student achievement between year of first entry and 2012 for establishments with 10 or more entries in at least one year

<table>
<thead>
<tr>
<th>Year</th>
<th>Establishments</th>
<th>A level Mathematics</th>
<th>A level Further Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>14</td>
<td>251</td>
<td>107</td>
</tr>
<tr>
<td>2006</td>
<td>19</td>
<td>494</td>
<td>69</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>146</td>
<td>33</td>
</tr>
<tr>
<td>2008</td>
<td>5</td>
<td>107</td>
<td>20</td>
</tr>
<tr>
<td>2009</td>
<td>2</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>53</td>
<td>17</td>
</tr>
<tr>
<td>2003</td>
<td>2012 change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>655</td>
<td>670</td>
<td>146</td>
</tr>
</tbody>
</table>

**Mean and Standard Deviation**

- **A level Mathematics:**
  - 2005: Mean 17.9, SD 9.7
  - 2006: Mean 26.0, SD 17.3
  - 2007: Mean 29.2, SD 19.1
  - 2008: Mean 21.4, SD 9.8
  - 2009: Mean 25.0, SD 19.2
  - 2010: Mean 34.5, SD 54.0

- **A level Further Mathematics:**
  - 2005: Mean 46.8, SD 8.7
  - 2006: Mean 61.3, SD 8.8
  - 2007: Mean 56.2, SD 11.8
  - 2008: Mean 46.0, SD 5.6
  - 2009: Mean 47.0, SD 4.19
  - 2010: Mean 86.0, SD 6.9

**Grade Points**

- **A level Mathematics:**
  - 2005: Mean 84.0, SD 6.7
  - 2006: Mean 97.0, SD 8.7
  - 2007: Mean 95.4, SD 8.8
  - 2008: Mean 93.0, SD 10.9
  - 2009: Mean 99.4, SD 21.4
  - 2010: Mean 89.1, SD 1.07

- **A level Further Mathematics:**
  - 2005: Mean 97.0, SD 6.9
  - 2006: Mean 95.4, SD 8.8
  - 2007: Mean 97.2, SD 11.8
  - 2008: Mean 93.0, SD 4.19
  - 2009: Mean 99.4, SD 21.4
  - 2010: Mean 89.1, SD 1.07
### Table 5.6: Change in cohort size and student achievement between year of first entry and 2012 for establishments with 4 or more entries, but less than 10, in at least one year

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Establishments</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>656</td>
<td>15.6</td>
<td>11.0</td>
</tr>
<tr>
<td>2004</td>
<td>1367</td>
<td>32.5</td>
<td>15.9</td>
</tr>
<tr>
<td>2005</td>
<td>1367</td>
<td>16.9</td>
<td>6.5</td>
</tr>
<tr>
<td>2006</td>
<td>711</td>
<td>5.5</td>
<td>10.7</td>
</tr>
<tr>
<td>2007</td>
<td>711</td>
<td>12.9</td>
<td>7.9</td>
</tr>
<tr>
<td>2008</td>
<td>510</td>
<td>15.6</td>
<td>10.4</td>
</tr>
<tr>
<td>2009</td>
<td>309</td>
<td>14.2</td>
<td>9.1</td>
</tr>
<tr>
<td>2010</td>
<td>109</td>
<td>14.1</td>
<td>9.0</td>
</tr>
<tr>
<td>2011</td>
<td>309</td>
<td>7.8</td>
<td>9.0</td>
</tr>
<tr>
<td>2012</td>
<td>152</td>
<td>32.5</td>
<td>12.7</td>
</tr>
</tbody>
</table>

### Table 5.6: Change in cohort size and student achievement between year of first entry and 2012 for establishments with 4 or more entries, but less than 10, in at least one year

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Students</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>82</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>2004</td>
<td>152</td>
<td>3.6</td>
<td>2.4</td>
</tr>
<tr>
<td>2005</td>
<td>70</td>
<td>1.6</td>
<td>1.4</td>
</tr>
<tr>
<td>2006</td>
<td>104</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>2007</td>
<td>79</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>2008</td>
<td>57</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>1.3</td>
<td>1.8</td>
</tr>
<tr>
<td>2010</td>
<td>-1</td>
<td>-0.7</td>
<td>2.1</td>
</tr>
<tr>
<td>2011</td>
<td>42</td>
<td>3.0</td>
<td>2.2</td>
</tr>
<tr>
<td>2012</td>
<td>87</td>
<td>3.0</td>
<td>2.4</td>
</tr>
</tbody>
</table>

### Data analysis of the impact of introducing Further Mathematics

**Table 5.7**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Students</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>82</td>
<td>99.8</td>
<td>22.0</td>
</tr>
<tr>
<td>2004</td>
<td>152</td>
<td>98.5</td>
<td>17.0</td>
</tr>
<tr>
<td>2005</td>
<td>70</td>
<td>102.9</td>
<td>19.2</td>
</tr>
<tr>
<td>2006</td>
<td>104</td>
<td>98.3</td>
<td>14.1</td>
</tr>
<tr>
<td>2007</td>
<td>79</td>
<td>106.5</td>
<td>18.4</td>
</tr>
<tr>
<td>2008</td>
<td>57</td>
<td>98.3</td>
<td>19.5</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>106.5</td>
<td>18.5</td>
</tr>
<tr>
<td>2010</td>
<td>-1</td>
<td>83.8</td>
<td>18.5</td>
</tr>
<tr>
<td>2011</td>
<td>42</td>
<td>99.1</td>
<td>19.0</td>
</tr>
<tr>
<td>2012</td>
<td>87</td>
<td>98.3</td>
<td>20.5</td>
</tr>
</tbody>
</table>
Appendix H  Stakeholders’ views on the FMSP

<table>
<thead>
<tr>
<th>Dave Adamson</th>
<th>Gateshead Local Authority</th>
<th>ref.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Further Maths Support Programme (FMSP) continues to provide an invaluable service to both our secondary schools within Gateshead LA and across the North East region as a whole. The need for such advice and support in this specialist area is clearly shown by the demand for both in school support and attendance at external Further Maths training events for staff. Indeed at a recent staff training event held in our LA, staff from as far afield as Tokyo and Glasgow attended the course. The Further Maths events for students are also very well attended with a wide variety of topical themes that make the subject very appealing and relevant to the audience. The success of this Programme begins with the continued funding and support of the FMSP and their continued work in lobbying the government to support this subject area in times of financial constraint across all Local Authorities. The success is also largely due to the hard work and professional dedication of the two FMSP regional coordinators who have adapted their strategies and work with schools very well to meet the changes in direction and approach required by the government and FMSP, e.g. more focus on the Key Stage 4 students as an early introduction to Further Maths.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bob Ansell</th>
<th>Senior lecturer in education Northampton University</th>
<th>ref.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have been working with FMSP and FMN for about five years now. In all of that time I have only positive things to record. In the early days we were well-funded to set up a further maths centre here in Northampton. The funding was later cut, when a new funding formula was introduced but we had enough to keep the centre running at a lower capacity. We have been very successful in rejuvenating further maths in Northampton. Over the years we have worked with a dozen or so local schools and colleges in a variety of ways. We have helped a few schools establish FM by tutoring for a year and then supporting them to take it ‘in-house’. We continue to help others by providing tuition here at the University of Northampton. In fact we have quite a large group here. We cater for about 20-25 AS students and anything from 3 to 10 A2 students. In addition we have off-site tuition managed by us. The help and support from the centre has always been excellent, either by email or by phone. The website offers great support to those we tutor, ourselves as tutors or to those who sign up for access to the resources. The online tuition has been very helpful to students especially for revision and in cases where we are unable to provide face-to-face support. I have always felt that the DfE have got very good value for money from the FMSP/FMN since I suspect that most people put in far more time, energy and hours than they are funded for. So, it is very good news that funding has been both increased and secured for five years. Let’s hope that this is a reality and not just a political move.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In my opinion, the Further Maths Support Programme continues to do an excellent job in raising the profile of mathematics in the South West region. This applied not only to pupils taking Further Maths A level, but also to many more potential high achievers in STEM subjects, from year 10 onwards. In this data-rich world of ours, a good maths background is becoming ever more a prerequisite for a wide range of degree programmes and careers and the FMSP seems to be doing more than most to make pupils aware of this fact.

The School of Mathematics at Kingston University was monitoring with interest the MEI pilot project “Enabling Access to Further Mathematics” in the early 2000s as we shared the general concerns in the HE sector that Further Mathematics as a secondary subject had become marginalised. Although meetings with Charlie Stripp and Richard Lissaman in early 2004 did not immediately lead to Kingston’s involvement in the project it did pave the way for a collaborative Expression of Interest with local schools in 2005. The outcome of this was that MEI decided the university should host the London SW Centre for the newly created Further Mathematics Network and this has continued to the present day under the restructured Further Mathematics Support Programme.

Kingston and its surrounding areas are fortunate in having some excellent schools which were already offering FM and through the work of the Kingston Centre and its superb manager, Jenny Davey, over the past 6 or 7 years many other schools have also been able to offer their pupils this qualification. Indeed, several of these schools seem now to be able to support FM from their own resources and this move towards ‘self-sufficiency’ is most encouraging. This strengthening of resources has allowed the Kingston Centre, in collaboration with the others from London, to increase its efforts in providing CPD to school teachers.

From the viewpoint of the university, although our mathematics courses at Kingston do not have Further Mathematics as an entry requirement, our perception (we have not attempted to collect data to corroborate this) is that those who do arrive here with that qualification seem to benefit from the greater breadth of topics which they will have studied. At least as importantly is that our involvement in the FMSP has created and cemented links between our School and the local secondary sector which might not otherwise have occurred. Indeed, the relationship has extended to local schools hosting our final year students on placement as part of the Undergraduate Ambassador Scheme and with our involvement in the SW London pre-initial teacher training course we feel that we are fulfilling our role as a civic university contributing to the local community. The FMSP really is a win-win-win scheme for pupils, schools and universities.
John Barrow FRS  Professor of Mathematical Sciences
University of Cambridge  ref.5

The FMSP remains an extremely successful and cost effective way to improve the mathematical knowledge and skills of many school children. It benefits those who wish to go on and study mathematics or statistics, but it is also crucial for those seeking to study physics and engineering, where there is going to be a large amount of applied mathematics in the first year of university courses. It is essential for those seeking admission to courses at Oxford or Cambridge or Warwick. The programme is expanding and has excellent national and regional leadership. The open days that expose further maths students and prospective students to some of the frontiers of mathematics and its applications are an important feature of the project. Although there are many popular lectures about mathematics around the country, it is important to provide a series of presentations that directly link the mathematics that students will study to real world problems in science.

The possibility for study of an AS as well as an A level in Further Maths was a very useful option and offers very valuable reinforcement of a student’s knowledge and facility for the A level course. It would be unfortunate if that option is removed.

The Further Maths programme is one of most valuable options for school students studying science and mathematics. It is a great example of a programme that avoids unnecessary administrative structures and brings the project leaders into close contact with students and very able teachers, who then interact with each other. It is a strong influence on schools, via students and parents, to hire their own ‘in-house’ teaching in this subject area. I am sure that many university science departments, and many technical businesses, wish that there were analogous Further Physics and Further Chemistry courses available as well.

Christopher Belsom  Chair IMA Schools and FE Committee  ref.6

You will judge from the initial responses from David Youdan and Nigel Steele that the IMA is very supportive of the work of the FMSP and everything that it does. I am happy to endorse that myself.

We are delighted to note the growth in numbers of students studying Further Mathematics, and believe that the FMSP can take significant credit for this. Our colleagues in Higher Education are particularly pleased and encouraged by this continued growth. The resources provided for students (and teachers) by the FMSP are excellent, and the opportunity for both students and teachers to engage with a like-minded community is most valuable. In addition to the provision at FM, the support provided at Key Stage 4 by way of enrichment courses is exactly what is needed to add interest and challenge to the GCSE curriculum. The FMSP provides a point of contact for teachers seeking help and support in some key areas of the mathematics programme in schools; it is a most valuable resource.
### Dr Robert Bowles  
**Department of Mathematics**  
**University College London**  
**ref.7**

Further Mathematics A-level is a required subject for applicants to our undergraduate degree programmes. We had concerns, surrounding fair access, with this policy. However we felt that the existence of the FMSP and our involvement with it, hosting a centre, allowed us to justify the policy. The continued expansion and success of the programme, including valuable CPD for teachers, means that we get up to ten applications for each of our places with almost all having taken the full A-level.

This increased level of preparation of our undergraduates over the past four or five years has been noticed by our first year lecturers. We are currently making our first year lectures more even challenging as a result. So the FMSP has supported our university teaching.

I am also happy to encourage the FMSP to move on to STEP/AEA support.

### Christopher Budd  
**Professor of Applied Mathematics**  
**University of Bath**  
**ref.8**

As a stakeholder in A level students I would like to say that Bath University strongly supports the FMSP. All of our current UK students have further maths and we have seen a significant increase in their ability to do our courses as a result. Indeed we have been able to increase the level of our first year courses. The existence of the FMSP means that an insistence on further maths qualifications does not prevent students coming to Bath from schools which might otherwise have problems in providing teaching for this.

We very much welcome this important means of widening the participation of students at Bath. We are also very pleased that the FMSP is working with us to help in the training of students for the STEP exams which give a great challenge to our brightest students. I am also pleased to say that we use the resource materials of the FMSP as part of our training of the calculus first year courses.

### Marcus de Sautoy  
**Professor of Mathematics**  
**University of Oxford**  
**ref.9**

The Further Mathematics Support Programme has played an invaluable role in creating a bridge between school and university level mathematics. To be able to offer students the possibility to do Further Mathematics I believe has contributed to the increased uptake in mathematics at University. Many students also get their first taste of university style learning and independent research through the programme which is an added bonus compared to those who actually get to study further maths in their school.
The Impact of the Further Mathematics Support Programme (FMSP) on Further Mathematics.

First and foremost, the FMSP has by its existence allowed vast numbers of exceptionally able mathematicians to have the opportunity to study Further Mathematics at their own schools whilst studying their other A Levels. More students are now studying Further Maths than ever before.

The online resources have played a vital role in supporting and delivering the programme and have also been a wonderful resource to other students studying mathematics.

The training and Continued Professional Development (CPD) that has come with the FMSP has been tremendous in helping to grow capacity in our schools so that the delivery of good Further Mathematics teaching can occur in a sustainable way for future cohorts of students.

The expansion of CPD events to support Gifted & Talented students at Key Stage 4 has been a recent innovation that has been hugely successful and welcomed by the Mathematics teaching community, and will certainly enhance the uptake of Mathematics and Further Mathematics study at A Level.

On a more local level for the impact on our students and staff at Little Heath School (LHS), having Jeff Trim as the Area Co-ordinator has been incredibly valuable for outreach work as part of our Science and Mathematics Specialism amongst local schools. Having host days at LHS and running the local KS5 network meetings at the school has also enhanced the growing sense of “Mathematical Community” amongst Berkshire Mathematics teachers. Furthermore our students have benefited from the FMSP enrichment activities such as competitions, lectures and interview preparation events. Also, our staff at LHS have gained valuable CPD when they helped run some events as well as attending the FMSP CPD events.

The FMSP has clearly played a key role in raising the profile of Further Mathematics in the North East. Involvement in Maths Team Challenges and A level revision days, which take place in a university setting, brings a normality to mathematics that breaks down barriers and encourages students to pursue the subject to a higher level.
Peter Giblin
Professor of Mathematics
University of Liverpool

The FMSP continues to flourish in Liverpool and the North-West. Martin Bamber has taken on a larger administrative and organizational role and the following are the activities which I know about.

CPD for teachers has expanded very significantly in the last couple of years. I attended the first CPD session 3 years ago and now there are regular sessions in two locations in the University of Liverpool and also in Chester. Martin also goes into individual schools or clusters on request. There was also an experimental STEP/AEA session recently in the University of Liverpool which I looked in on: this involved teachers and students from local schools working with questions from these demanding examinations, under the guidance of three experienced tutors.

Revision classes: the traditional revision classes for A level were not attracting the ‘right’ students, that is ones with lower predicted grades who would really benefit from such classes, and at a new venture in January this year about 130 targeted VI formers came to the University and worked in small groups with a PGCE student or a tutor on a series of activities designed to improve their confidence in the material.

Enrichment: this is now an established part of the provision. I took part in the Mathemagic 2012 session (designed for end of year Year 10 students), and a new Year 11 workshop is planned for the end of March, targeting priority schools. This is an exciting development (already ‘sold out’) which unfortunately I shall miss through being away. Mathemagic will take place again this summer.

Mathworks: in association with the Institute of Mathematics and its Applications a ‘maths in the workplace’ event took place last summer, for Year 12 students. This was very successful and will be repeated this year. I was involved in recruiting some of the speakers, and I can confirm from them that the event was well planned and much appreciated by the students.

Martin continues to be an enthusiastic leader in the provision here in the North-West; I know that he works closely with his counterparts in Manchester and Lancaster. He goes into individual schools for enrichment or CPD and is much involved in organizing the numerous events which take place in Liverpool, Manchester, Chester and also in other places such as Barrow. I keep in touch with developments, as well as being a tutor for FP2 at one of the local schools which still needs outside tutoring.

Dr Paul Glaister
Head of Department of Mathematics and Statistics,
University of Reading

In my experience, students who have taken Further Maths are much better prepared for university study of any degree programme which has a significant mathematical content, including mathematics, science, engineering and social sciences such as economics and business. In terms of exposure to important mathematical concepts, support for core mathematics, improvement in general mathematical skills and maturity, together with the enhanced ability to study independently, Further Maths students definitely have an advantage over regular A level students. The University of Reading has benefited greatly from being part of the Further Maths Support Programme, not least because of the contact it has had with local maths teachers and pupils, and the joint ventures that they have been involved in, and look forward to continuing this partnership as the Programme develops further. We very much value the contributions the programme has made over the years.
The FSMP work has now diversified well beyond direct support for FM of course, though their enrichment events and teacher development all build up both mathematics teacher capacity and student and teacher enthusiasm, and consequently participation in FM and beyond. Learning FM at a distance, the original focus, has always been hard, and students have to *learn* to use online resources; the critical learning for almost all students is in face-to-face sessions (with the FSMP providing as much of that per student as many centres are able to do). This can be well-supported by FSMP *Elluminate* distance learning sessions: many students who might have only limited direct teaching, and/or small FM group size, find those very helpful. Recent developments in providing support for STEP/AEA are excellent, but pricing is prohibitive for some students from some (usually more poorly-funded) schools: ways to alleviate this challenge of access would be valued.

FSMP teacher development sessions for Key Stage 4/5 teaching are generally well-regarded, though there is some concern in the community that the FSMP has an 'unfair advantage' over equally good CPD providers elsewhere in being able to offer subsidised CPD. Enrichment/motivation events are excellent: again, a further improvement would be to vary the location more, to offer access to other schools and students (there being teacher benefit in these as well as student).

I think we have reached a stage where enough schools now have teachers able to teach further maths (both in terms of expertise and time). What we need to do is to support them in doing so. The FMSP provides a number of opportunities for teachers of mathematics to develop their knowledge and teaching skills across a range of modules in both A level maths and further maths, including STEP and AEA level maths. This is much more cost effective, since the benefit from one teacher over several years is to many students.

This should be supported by enrichment events for students in Key Stages 4 and 5, which again reaches both teachers and students. It also gives a feeling of a wider world. The FMSP also promotes mathematics as a worthwhile area of study although the effect of this is harder to measure.

As far as our own experience in Sheffield is concerned, I think it is perhaps too soon to really have a measurable consequence. The feedback from schools does not always separate the FMSP aspects of benefit from the other benefits that our local Area Coordinator brings, but it is very positive on enrichment events and the promotion of mathematics as a worthwhile area of study post-16.
Professor
Stephen Hibberd
School of Mathematical Sciences
University of Nottingham
ref.17

It is encouraging that at Nottingham, more well qualified students are opting to take our mathematics courses so particularly pleased that FMSP is maintaining an emphasis on enabling schools, and notably KS5 Priority Schools, to consolidate student learning of Further Maths. Extended activities to Key Stage 4 for improvements in A/A* GCSE Maths is laying the foundation for greater achievement in A/AS GCSE for future students. These activities are going hand-in-hand with broader local support mechanisms to Schools and CPD in AS/A2 Maths / Further Maths both on-line centrally but also to regional events.

Dame Julia Higgins
Chair Advisory Committee on Mathematics Education
(ACME) 2008 to 2012
ref.18

From September 2008 to January 2012 I chaired ACME – the Advisory Committee on Mathematics Education. Throughout that time I heard many references to FMSP and its predecessor FMN from committee members, all of whom were deeply involved in maths education. There was approval of the way these programmes have been making Further Maths accessible to pupils in schools without suitably qualified, or perhaps sufficiently confident, maths teachers. It was noted that the numbers of entries in both Further Maths and Maths “A” levels were steadily increasing over the period and FMSP was acknowledged to be a key factor in this success. Not only were more pupils enabled to study further maths but by supporting maths teachers more generally the quality of maths teaching has undoubtedly been enhanced.

Professor
Celia Holyes
Director National Centre for Excellence in Mathematics Teaching
ref.19

FMSP has been a brilliantly successful project that has evolved over the years in line with the changes of context. We have many more teachers qualified to teach Further Mathematics in house.

Professor
Martin Hyland
Department of Mathematics
University of Cambridge
ref.20

The FMSP has been successful beyond best expectations. It has evidently had a massive impact on the take-up of Further Mathematics A level both by its direct provision of support and by its influence on A level provision in schools. From the point of view of ambitious HE it is far and away the most important initiative in Maths education in the last 10 years.

In addition the creation of a Network across the country, comprising dedicated people who know local schools and liaise with local Universities, is a very welcome development in itself. The UK can expect to profit from that in many ways.

The Cambridge view of the FMSP is overwhelmingly positive.

Dr Niall Mackay
Department of Mathematics
University of York
ref.21

The FMSP has played a crucial part in the resurgence of advanced mathematics in schools over the last decade. They began by providing extramural classes for the Further Maths A level, but have shown enormous initiative and flexibility in broadening their offering to include a range of courses for students and teachers. The FMSP shows what can be achieved when enthusiasm, initiative and superb organization are allied to a clearly understood and shared vision. I hope they will continue contributing such qualities to mathematics education for a long time to come.
The FMSP goes from strength to strength, as the numbers taking FM AS and A-levels mathematics continue to rise. More and more physics and engineering departments are seeing the value of entrants who have some background in FM, giving them extra fluency in mathematical manipulation which is such an advantage in the early years of university study. As mathematics more generally is appreciated by students of all subjects, correspondingly, in those areas where mathematics is essential, students are increasingly aware of the extra benefit of Further Mathematics and the Support Programme ensures that few students are disadvantaged by a lack of access to a suitable teacher. The Programme offers a model from which we can all learn.

The Further Mathematics Support Programme has been instrumental in raising the profile of mathematics in the region. In particular, it has helped to forge closer links between the University and Schools and Colleges in the South-West. We have certainly seen more students with further maths in our programmes over the past few years and this can be traced back to the support and advice they are getting at school through the FMSP.

From our point of view the resources now available for IGCSE Further Maths (AQA) and A-level Applied have been invaluable. They provide an opportunity for students to develop independent learning skills so invaluable later on at university. They also give teachers an excellent bank of resources to use in lessons.

As a Teaching School we have become involved in delivering and participating in FMSP inset and all of our mathematics teachers can teach A-level confidently, six of us can now teach Further Maths confidently and four of us can deliver AEA/STEP tuition. This is a huge benefit to us in terms of the opportunities we offer our students. It is also a huge asset in that it allows us to form collaborative networks with other schools to spread the work of the FMSP through our own "Teaching School" work.

We were a pioneer school in offering the AQA IGCSE certificate in Further Maths in order to improve the post GCSE experience of our students and pave the way for their potential study of A-level. The FMSP were quick to act on our suggestion to add resources to their excellent "Integral resources site" that support this qualification.

I find the FMSP to be responsive in meeting the needs of schools in the rapidly changing curriculum climate, creative in the resources they provide and complete in their coverage of the curriculum. The next phase for me would be to match up AEA/STEP resources to the A-level curriculum and have these readily available to teachers and students.
The country needs more well-qualified engineers, and the engineering profession is engaged in much work to encourage young people to go on to study engineering and technology at a higher level. Encouraging young people to continue with mathematical studies is key to this. The work done by the MEI to support and extend the provision of Further Mathematics, particularly in the state sector, has made an important contribution to enabling more students to access A level Further Mathematics and thus broaden the engineering and technology opportunities open to them.

Dr Carol Robinson  
Head of Department,  
Mathematics Education Centre  
Loughborough University  
ref.26

The FMSP in the East Midlands is now organised jointly between Nottingham, Loughborough and Northampton Universities. The appointment of an additional area coordinator in Northampton in January 2013 is much welcomed as it allows our area coordinator to focus on the areas of Leicestershire and Lincolnshire. Kevin Lord has taken over from Richard Lissaman as our FMSP advisor and attends our regular executive management meetings. These meetings were held monthly, but now that the new KPIs are well understood we have changed these to termly meetings (at Loughborough, Nottingham or Northampton).

Kevin is excellent at ensuring that we understand clearly what we should be delivering and what extra funding or admin support is available for this. The extra funding for major events and to employ associates has been a great benefit. There has been more of a focus recently on ensuring that we try to get schools themselves to provide tuition and in helping them to do this, rather than delivering the provision ourselves. This is a much more sustainable model. Moreover the regular updates from the FMSP team informing us about the schools in our area which we need to target, because they do not offer Further mathematics, are very helpful.

Our area coordinators in Nottingham and Loughborough continue to offer a very wide variety of enrichment events. Recent events include ‘Suspense’ and ‘Rollercoaster’, which each attracted about 150 school children, Saturday morning master classes, Maths in the Environment and Maths in Fashion workshops, STEP and AQA classes and CPD for teachers in this area. There were Year 10 and Year 12/13 challenges, attracting a large number of teams from across the region. The effect of these events is to raise the profile of mathematics and its study at A-level and beyond. They are very popular with local schools.

CPD for teachers continues to feature strongly in our provision.
Professor Graham Rogerson
Head of the School of Computing and Mathematics
Keele University

Over the last few years we have seen substantial increase in undergraduate mathematics entrants here at Keele. Our current final year is nearly three times the number of 5 years ago, with a six-fold increase in those entering with full A-level Further Maths. The interaction with local schools brought about by our involvement with the FMSP is, in my opinion, the greatest single reason for this increase.

Impressive though the above increases are, I think that the true benefit of the FMSP is that the students are very much better prepared for the rigours of undergraduate mathematics. Moreover, we in the universities, through our interaction with the FMSP, have a much better understanding of how best to support students to achieve their greatest possible potential. At Keele, this has helped us smooth the particularly difficult transition from school to university mathematics. It is indeed no coincidence that we enjoy particularly high retention rates for Mathematics, 97.9% in 2011/12, and are usually in the top 5 nationally for student satisfaction. I cannot really imagine such metrics being possible without the FMSP.

The collaboration with local schools has helped enormously to raise aspirations in socially challenging local areas. In my opinion, this has had a significant positive impact at Keele far wider than just within mathematics. Much highly significant and noteworthy work has already been done. As always seems the case however, there is still a great deal to be done and many challenges to overcome. I was particularly pleased to see the excellent recent initiative of the development of Key Stage 4 enrichment and CPD events. This is an area within which I see enormous need for development locally.

Professor Colin Sparrow
Head of Mathematics Institute
University of Warwick

The Further Maths Support Programme is an extremely successful initiative which continues to go from strength to strength, reinvigorating itself to meet the fresh challenges set by its stakeholders and the wider society. It plays an essential role in raising the profile of mathematics, and in stimulating students to aspire to the next level of their studies. The support provided through the Programme is often commended by students and schools alike. This includes the support classes, the CPD training offered to teachers, the on-line resources, various enrichment events and revision days. The continuing success of the Programme is paramount and has been a key driver in our decision to invest significant university funds in additional but complementary activities, such as problem-solving days for year 12 students, STEP/AEA support through web/on-line lecture delivery and professional development days for teachers, Saturday Royal Institution Master classes, and additional Maths and Beyond Days. The success of these activities is dependent on the close links with local schools established through the Programme, ensuring that the students who have the least support are again the focus.

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.
The FMSP has made an important contribution to the increased popularity and awareness of the Further Mathematics A-level and the subject in general. The excellent distance learning tuition and materials have enabled hundreds of students to take Further Mathematics A-level in colleges and schools which are unable to offer formal classes. These resources and CPD training for teachers have also enabled many centres to run their own Further Mathematics classes. As well as being an important prerequisite for Mathematics degrees, Further Mathematics also supports other subjects such as Physics and Engineering and therefore the FMSP is indirectly supporting many undergraduate courses. At University of Manchester we have seen a steady increase in the number of students starting a mathematics degree with an A-level in Further Mathematics and the overall quality of applicants to our programmes. I believe this is a partly due to the excellent work done by the NW centre of the FMSP.

From its original emphasis on distance learning support, the FMSP has grown to include a broader range of activities. Our regional co-ordinators have developed excellent outreach activities to promote the higher study of mathematics by making school students aware of the power and beauty of the subject and its many applications to solve real world problems. Students attending enrichment events are introduced to the broad range of exciting careers available to people with high level numerical skills. I am convinced these activities have helped to increase interest in the study of mathematical related subjects at university.

At Wolverhampton we have been involved with the delivery of Further Maths teaching to students from local schools since 2003 and have been one of the Further Maths Centres since 2005. During that time we have a very good record of making contact with Mathematics Departments, providing the Further Maths teaching and in some cases helping them to take up the teaching of the subject in their own schools. In addition the Centre has organised various events such as Year 10 Maths Fun days, Gifted & Talented workshops, Further Maths Conferences, Royal Institution lectures, and revision days. We also host the regional UKMT Senior and Junior Maths Challenges each year, and have provided CPD for local Maths teachers.

We consider all of these to be valuable activities in promoting the Subject and encouraging more students to continue with their Mathematical studies beyond GCSE, and ultimately to produce more Maths graduates and more effective teaching of the Subject. This has all been made possible by the funding provided by the FMSP, so I would fervently hope that this may continue.