
Enabling Access to Further Mathematics

The MEI/Gatsby project

How to give ALL sixth formers the opportunity to study for Further Mathematics ASA/A levels

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Mathematics in Education and Industry (MEI) is a curriculum development organisation, responsible in terms of student numbers for the second-largest Mathematics A level specification.

The MEI specification is examined by OCR.

Further Mathematics is in trouble. Student numbers have declined drastically and many schools/colleges, especially in the state sector, no longer teach it. Should we allow it to slip quietly into oblivion, or should we try to do something positive to save it? I say we must save it. If we don't we will be party to a real reduction in the quality not just of the sixth form mathematics provision but also of the intellectual environment within which we nurture our brightest students. The demise of Further Mathematics is not inevitable. We can save it, and in a way that will have a very positive influence on the whole of post-16 Mathematics education.

To find out how, read on.

Background

The number of students taking Further Maths A level has fallen from about 15,000 in 1980 to about 6,000 today. The main reasons for this decline have been the high costs of running small classes and the shortage of suitably qualified teachers, particularly in the state sector. Curriculum 2000 has now compounded the situation in two ways:

1. Curriculum 2000 encourages students to choose a broad range of subjects. I believe this is a good thing. However, incredible as it may seem, it has led to students being incorrectly advised that to do Further Mathematics is a narrowing option, which will damage their chances in higher education and employment.
2. The Curriculum 2000 changes have made Mathematics significantly more difficult than other subjects for the majority of students. This has resulted in fewer students choosing to study Mathematics at A level with a knock-on effect on Further Mathematics.

This new threat to Further Mathematics puts the standard of pre-university Mathematics in danger. There is also an equal opportunities issue; it is a matter of chance whether a keen/able sixth form student has the opportunity to study Further Mathematics in school/college.

Students in schools/colleges that do not offer Further Mathematics qualifications are often unaware even that they exist, until they get to university to study for a mathematics-based degree and realise that a lucky few have done Further Mathematics and are at a major advantage. The country needs more graduates in Mathematics-based subjects like Engineering, Physics, Computing and Mathematics itself. Currently, insufficient numbers of students are choosing these courses.

The standard Mathematics A level is trivial for many able students and so fails to provide the stimulation to take the subject further. We need to inspire these students to go on to Mathematics and Mathematics-related university courses. Access to Further Mathematics can make a big difference.

The MEI 'Enabling Access to Further Mathematics' project is a distance learning/learning support project designed to ensure that every suitable student has access to Further Mathematics. The project enables sixth form students to study for Further Mathematics qualifications, even if they are

attending a school or college that is unable to offer them directly. The project is now in the final year of a three-year pilot, funded by the Gatsby Charitable Foundation. The pilot has been extremely successful. From September 2003 a major expansion is planned, to begin the transformation of the project from a fairly small-scale pilot to a national provision.

How does the project work?

There are many people who have the skills necessary to teach Further Mathematics; they are just not in the right places:

- Some are teaching in schools/colleges with a healthy Further Mathematics provision
- Some are teaching in schools and colleges that do offer Further Mathematics, but are teaching very small classes, often on reduced timetable provision, which are constantly under threat
- Some are teaching in schools/colleges that do not offer Further Mathematics
- Some work in universities
- Some have left teaching
- Some are retired

On the one hand, the expert skills of many of these people are under-used, whilst on the other hand there are large numbers of students denied the opportunity to make use of their skills.

The project enables students to use 'supported self-study' to learn Further Mathematics, whilst receiving support from a tutor, who may be a 'distance-tutor', based at a project 'lead centre', or who may be based in their own school or college. See fig 1.

The project's structure links together institutions in such a way that staff with the necessary expertise to teach Further Mathematics can be connected with students who wish to learn it. In some cases, it also gives students a first experience of their local university's Mathematics department.

Students study Further Mathematics modules using MEI module textbooks, supported by extensive structured resources on a web site.

The project's resources support the MEI Further Mathematics specification. Within the time and funding available it would have been impossible to support more than one specification. However, MEI Further Mathematics AS and A levels follow on from any of the standard Mathematics A level specifications, so no students are excluded from them.

How is a student's study supported?

- Students follow a programme of supported self-study.
- They have access to the project's web site, www.mei-distance.com, which has purpose-written, structured resources to support MEI A/AS modules.
- They have a tutor who manages their studies and provides:
 - regular tutorials, either by video-conferencing or face-to-face.
 - support by email and fax
- Where students are distance-tutored, their tutor works in liaison with their school/college
- They attend 'Study days' once or twice each term at their local lead centre, to support coursework (where necessary) and exam preparation.

The web site

The web resources provide a clear structure for students to work within, guided by their tutor. The resources for each module are designed to be used alongside the module's MEI textbook. The resources are split into chapters, which mirror the chapters in the textbooks. These chapters are further broken up into 'units'. Each unit contains a coherent section of work. This structure encourages students to make effective use of their textbooks. Usually students use mathematics textbooks only to find the exercise questions they have been set for homework and to look at the answers in the back. To learn mathematics by supported self-study means they will need to study the bits between the exercises, which is also a very useful skill to acquire for future education and employment.

The web resources contain:

- Study plans
- Supplementary notes to expand and enhance the textbooks
- Common mistakes sections with explanations and examples
- Glossaries, which explain mathematical terms and definitions in the context in which they are being studied
- Diagnostic multiple-choice tests
- Purpose-written interactive spreadsheets
- Hints and worked solutions to questions from textbook exercises
- Worked solutions to examination papers
- Links to other relevant web sites

The web site is a very valuable resource for teachers and students, whether or not it is being used to support distance-learning.

Tutorial support

The project is looking for information on the most effective way to tutor students, so a variety of models have been tried in the pilot. The basic framework is:

- Students receive at least 45 minutes of tutorial contact once a fortnight, usually in groups of two or three.
- Students receive a schedule for working through the web resources. This should be agreed on an individual basis and regularly reviewed.
- Where tutoring is by video-conferencing, a physical face-to-face meeting should be arranged at least once each term.
- Students receive feedback on their progress at least once a fortnight.
- Students' chapter assessments are marked and returned within seven days.
- The Student Guide, which may be downloaded from 'New users' section at the front of the web site, contains advice to students on how to use the web resources and textbooks and how to manage their studies.

At the Exeter College pilot lead centre, Bob Francis and I have experimented with video-conferencing for long-distance tutoring, using a shared white board and cheap graphics tablets. We have found it is effective for up to four students together at the member centre.

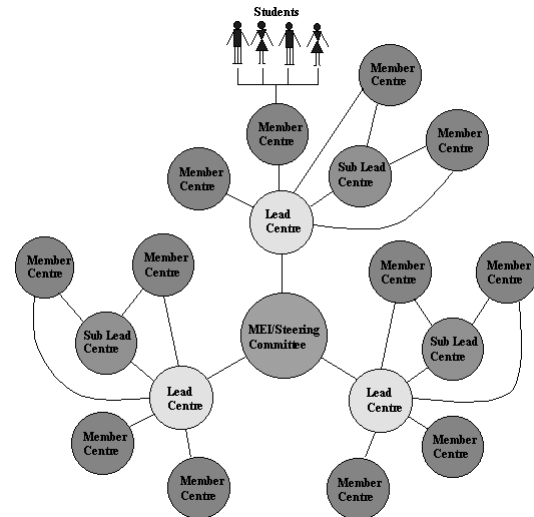
Adrian Hall, the lead centre director from the St Thomas More lead centre in Blaydon, went into Newcastle College after school for an hour each week to tutor a class of students in Further Maths.

At Warwick University the lead centre director, Richard Lissaman, made regular tutorial visits to the three local schools he was working with during the pilot phase. This year he plans that his students will come to him, meeting at Warwick University on Wednesday afternoons.

Email contact in the period between tutorials is also encouraged.

Each of these methods was effective. Local circumstances dictate how best to tutor students within the basic framework.

Figure 1: MEI 'Enabling Access to Further Mathematics' project structure



Lead centres are likely to be universities or other large institutions. **Sub lead centres** are likely to be smaller colleges and schools that have the expertise in-house to teach Further Mathematics. **Sub lead centres** can provide distance-tutoring to students from other schools and colleges in their locality, but still benefit from linking to a main lead centre for study days and possibly for support with teaching certain modules. **Member centres** are schools and colleges where students who are being supported by the lead centres are based.

What happens in tutorials?

At the start it is necessary actually to teach the mathematics directly. Later, with encouragement from the tutor, students become much more independent and tutorials become trouble-shooting sessions, with the students doing a large amount of independent learning using the web site and their textbooks.

We have found it effective to agree the content of each distance-tutorial by email in advance. Tutorials then involve explaining some more difficult concepts or examples and sorting out specific problems that students are having with questions. This format is found to make efficient use of the limited time available. Throughout the course, developing students' study skills is a vital part of the tutor's role.

Study days

These are usually hosted at lead centres. Local students spend a whole day concentrating on their Further Maths,

usually with a focus on coursework or on revision and examination preparation. They enable students to meet one another and their tutors face-to-face for an intensive day of study. Feedback from both students and staff has been extremely positive.

What has the project's pilot achieved?

The pilot has shown that the project works! Further Mathematics can be taught effectively in by distance learning and it is possible for different sections of the education system to link together for the benefit of both students and mathematics education.

During academic year 2001/2 the project provided distance-tutoring to 47 students. These students were tutored from September/October 2001 through four lead centres. Warwick University and St Thomas More School, Blaydon were funded through the project. Exeter College, in Devon, is a lead centre with funding from the Learning and Skills Development Agency and from January 2002, UMIST is a lead centre, funded from UMIST Mathematics' department outreach money.

Students were accepted onto the project on the basis that they were keen to do Further Mathematics and were studying Mathematics A level in their school/college. No other selection criteria were used.

Results

Results from students completing qualifications through distance-learning this summer were:

Student	AS level FM grade (via the project)	Standard A level grade (through their school/college)
1	A	A
2	A (full A level)	B (taken early)
3	A	A
4	B	A
5	E	C
6	A	A
7	A	A
8	B	A
9	E	D
10	U	U
11	A	A
12	A	B
13	B	A
14	D	C
15	D	B
16	E	B
17	B	A

The remaining 30 students were in year 12 (lower sixth) and so will complete their AS/A levels in Further Mathematics in June 2003. They all sat module exams during 2001/2 and have achieved some very encouraging results.

These results show clearly that students were able to succeed in studying Further Mathematics in this way. Comparison of students' Further Mathematics grades with the grades they achieved in their standard Mathematics studied at school/college shows a profile very similar to that which one would expect for students being taught Further Mathematics by traditional means.

As well as succeeding in their exams, the students and their teachers were also very positive about the experience of studying through the project. Study days in particular were well received by both distance-learning students and students being taught traditionally in school/college.

Wider issues

The project is much more than just a distance-learning project. Its resources can be used by any student or teacher involved in Further Mathematics. Lead centres can link their local Further Mathematics community together. Teachers in schools and colleges where Further Maths is not taught or is under threat can be involved. Tutors can be recruited from experienced teachers who have left the profession, thus making use of their much-needed expertise. The project encourages schools, colleges and universities to collaborate. This enables more students to access Further Mathematics and gives them the opportunity to become more engaged with Mathematics. If we can inspire more students we will raise the standard of post 16 mathematics education and attract more high-quality undergraduates into the Mathematics-dependent degree courses where they are desperately needed.

To find out more about the project, or if you are interested in becoming involved, please contact Charlie Stripp, Project Coordinator, email charlie.stripp@mei.org.uk