

Unwinding the Vicious Circle

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Summary

Recent changes to the structure and provision of AS and A Level Mathematics and Further Mathematics hold out the hope of better qualified new undergraduates setting out on degree courses with a substantial mathematics content, including engineering.

The changes need to be seen as a complete package which, taken as a whole, will allow mathematics to escape from a vicious circle that has resulted in decreasing numbers of students taking mathematics post-16 and mounting dissatisfaction from end-users.

This paper explains the relationship between the different parts of the package and the actions that particular stakeholder groups must take if it is to be successful.

Requirements for a better Mathematics provision

Regulators

- Resist pressure to make A Level Mathematics harder, including the idea of incorporating AEA style questions into the papers.
- Address the myth that all subjects are equally demanding, and the problems resulting from it.

Schools

- Promote both Mathematics and Further Mathematics and, if appropriate, have students tutored through the Further Mathematics Network.
- Recognise that many students can benefit from Further Mathematics, not just the very brightest.

Universities

- Take an active role in the Further Mathematics Network.
- Adopt admissions policies that are seen to reward those who have successfully taken Further Mathematics.

1. Introduction

1.1 *Historical background*

Twenty five years ago the number of students taking A Level Mathematics was about 100 000 each year¹. The number fell steadily but not dramatically during the 1980s so that by 1989 it stood at about 85 000; in the early 1990s the numbers fell more sharply; by 1993 they were down to 66 000.

We will never know for certain why numbers fell so drastically at that time because no research was done into the reasons. However, a plausible conjecture is that this was a time when increasing numbers were staying in education post-16 and new courses were developed for these non-traditional students. Many of these courses were, by design, more accessible and several well established A Level subjects, including Mathematics, Further Mathematics, Physics and Chemistry, lost out in a market-place competition with easier alternatives.

Whatever the cause, the scene was set for a national disaster in which our mathematics provision became caught in a vicious circle.

The falling numbers meant that to fill their places, universities had to accept mathematically weaker students onto science, technology, engineering and mathematics courses. By the mid-1990s they were complaining vociferously about “falling standards”. That produced a political response that mathematics must be more demanding. The effect was to ensure that mathematics was an even less attractive option for 16-year old students, with the result that universities were selecting from an even smaller pool. And so on ...

A new government was elected in 1997 and shortly afterwards work began on a new post-16 curriculum, to be called Curriculum 2000. Students would do more subjects but stop some of them at AS Level, after one year. Overall it meant more work for students and many subjects responded by reducing their A Level demands. However, in the light of the “falling standards” complaints from universities, no reduction in demand was allowed in mathematics; instead the conditions surrounding the examinations, for example assumed knowledge and access to formulae, were made significantly more severe.

The effect was catastrophic. The number of students in the first Curriculum 2000 cohort who completed A Level Mathematics in 2002 hit an all time low of about 50 000. This was a reduction of 19% from the previous year, and just half the number of twenty years previously. Needless to say there was a knock-on effect on universities; they were confronted with even deeper problems than they had already been facing.

Following the disaster of Curriculum 2000, the government instigated a number of measures which have the potential to do much to improve the situation. The first students to be affected by these were to be those completing A Level in 2006. However, special transition arrangements meant that some of the 2005 cohort were able to transfer into the new syllabus.

1.2 *The Vicious Circle*

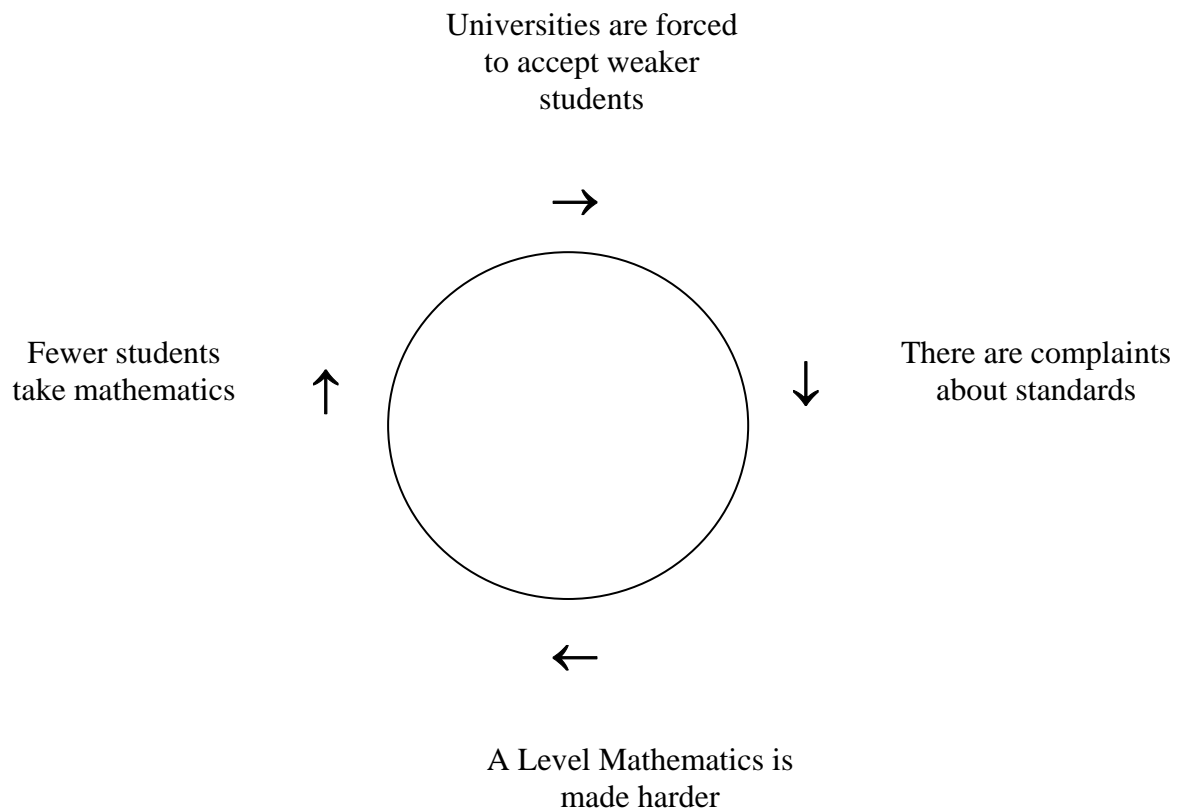


Figure 1: The Vicious Circle

Three groups of people were involved in the vicious circle:

- teachers in schools and colleges;
- university lecturers;
- regulators.

Each group knew about its own world but not enough people, it would seem, had an overview of the whole situation.

This was particularly true of the regulators. They are the politicians and the civil servants who advise them, and it is they who make the rules. It is their collective responsibility to be aware of the complete picture.

1.3 A Level numbers

Table 2 gives data on A Level numbers². This shows not just the reduction in actual numbers but also in the proportion of A Level entries that are in mathematics. It is a truly frightening picture.

Year	Total candidates	Mathematics candidates	Mathematics percentage
1989	661 591	84 744	12.8
1990	684 117	79 747	11.7
1991	699 041	74 972	10.7
1992	731 024	72 384	9.9
1993	734 081	66 340	9.0
1994	732 974	64 919	8.9
1995	725 992	62 188	8.6
1996	739 163	67 442	9.1
1997	777 710	68 880	8.9
1998	794 262	70 554	8.9
1999	783 692	69 945	8.9
2000	771 809	67 036	8.7
2001	748 866	66 247	8.8
2002	701 380	53 940	7.7
2003	750 537	55 917	7.5
2004	766 247	58 508	7.6
2005	783 878	58 830	7.5

Table 2: A Level Mathematics Numbers

2. Meeting everyone's needs

2.1 *The tension between quantity and quality*

If the system is working well, our mathematics provision post-16 should fulfil two requirements.

- It should attract a large number of students to continue mathematics after GCSE.
- It should provide those students with a good standard of mathematical knowledge and competence.

A possible conclusion from the previous section might be that these two requirements are mutually incompatible. That would indeed be the case if the single A Level was the limit of the mathematics available to school and college students. Fortunately that is not so because we also have Further Mathematics.

This makes it possible to set the single A Level Mathematics at a standard that will attract more students, and at the same time to meet the needs of stronger students, and the expectations of the universities they will go to, through Further Mathematics.

2.2 *Further Mathematics*

Over the last twenty five years Further Mathematics numbers have fallen, proportionately, even more than those for the single A Level Mathematics, from about 15 000 to 5 000. There was a time when it was taken for granted that a student applying to university to read mathematics had Further Mathematics as an A Level. (The number taking Further Mathematics used to be several times greater than the number going on to read mathematics.) Now most universities are reluctant to mention it in their prospectuses for fear of frightening off potential applicants.

The reduction in the uptake of Further Mathematics during the 1980s and 1990s was undoubtedly another factor in the perception among university mathematics departments that standards were falling. It was not just that new undergraduates were arriving knowing less mathematics but that they had spent much less time doing it, and so were less fluent.

There are a number of reasons why a strong Further Mathematics provision is important. As already explained, it allows the needs of a wider range of 16- to 19-year old students to be met, from those who are very able to those who will benefit from mathematics post-GCSE but do not find the subject particularly easy.

A different reason is that students are genuinely excited by the powerful new ideas they meet in Further Mathematics. While many find the single A Level very difficult, there are others for whom it is trivial. Such students can actually be turned off mathematics by the lack of challenge in both the single A Level and GCSE; it is often the case that Further Mathematics restores their enthusiasm and provides them with the incentive to read a subject with substantial mathematical content when they go on to university.

There is perception that the main beneficiaries of Further Mathematics are those going on to read mathematics at university. This is not actually the case. Many science, engineering and technology undergraduates find their main course of study undermined because they lack the necessary mathematics background. Such students stand to benefit greatly from the extra knowledge and experience that they bring with them from having taken Further Mathematics; it allows them to concentrate more of their efforts on their main subjects.

2.3 Recent changes

Following Curriculum 2000, the government has approved three major measures to improve the situation.

- The content of the single A Level has been reduced by $\frac{1}{6}$.
- Further Mathematics has been made more accessible; at AS Level, it can now be studied alongside AS Mathematics, immediately after GCSE.
- Further Mathematics is being promoted through the Further Mathematics Network.

Taken together, these changes have the potential to allow the vicious circle to be unwound. With increases in the numbers taking the single A Level, and in those taking Further Mathematics, universities will not be forced to accept such weak students. This should, in turn, remove the pressure on the single A Level, allowing it to be set at a standard that will continue to restore the uptake.

However, there are many ways in which this somewhat optimistic scenario could be undermined. These relate both to AS and A Level Mathematics and also to Further Mathematics.

3. Problems related to AS/A Level Mathematics

3.1 AS standard

While the uptake of A Level Mathematics is now higher than it was in 2002, it is still far below an acceptable level.

One of the major outstanding problems is that AS Mathematics is harder to pass than almost all other subjects. This is illustrated in Table 3 which gives the pass rates for a number of subjects at AS Level from 2001 to 2005³. Although those taking mathematics are among the most able students in the cohort, the pass rate at AS Level is consistently among the lowest.

The message to students is clear. Unless you are really very good at mathematics, it is a risky subject to take; you would be safer with English or Media studies.

The message to schools and colleges is also clear. If you take your league table position seriously, discourage your students from taking mathematics.

Subject	2001		2002		2003		2004		2005	
	Rank	Fail	Rank	Fail	Rank	Fail	Rank	Fail	Rank	Fail
Welsh	1	2.8	1	2.2	1	0.9	1	1.7	1	1.6
Classics	2	4.0	2	4.2	3=	4.7	4	4.6	4=	4.4
Express Arts	3	4.3	3	4.4	3=	4.7	2	4.0	2	3.5
Music	4	5.2	9=	8.5	8=	8.0	12	8.2	15	8.8
English	5	5.3	5	6.2	5	5.3	6	5.2	4=	4.4
History	6=	6.4	8	7.9	7	7.2	8=	7.0	9	6.1
Media St	6=	6.4	4	5.9	6	5.1	5	4.8	6	4.6
French	11=	9.0	16=	10.4	14	8.8	15	9.1	14	8.6
Spanish	11=	9.0	14=	9.9	11	8.4	11	8.0	10	7.1
Geography	13	9.2	14=	9.9	16	9.2	16	9.7	16	9.7
Business St	20=	13.0	21	13.1	21	13.2	22	13.7	21	13.4
Chemistry	20=	13.0	22	13.3	22	14.4	23	15.1	23	14.9
Sociology	22	13.5	23	14.8	23	14.8	21	13.5	22	13.6
Physics	23	13.9	24	15.4	25	16.0	25	16.5	24	16.1
Biology	26	15.6	26	17.1	27	18.3	27	18.0	27	17.3
Psychology	27	17.2	27	17.3	26	18.0	26	17.9	28	17.9
General St	28	18.1	28	19.9	29	19.3	30	19.3	30	19.0
Computing	29	19.5	30	21.7	31	21.9	31	20.0	31	20.3
Law	30	20.5	29	20.6	28	18.7	28	18.6	29	18.1
Mathematics	31	28.6	31	22.1	30	19.9	29	19.1	26	17.4

Table 3: AS rankings 2001-2005

3.2 *The idea that all subjects are equally difficult*

Table 3 shows quite clearly that some subjects are easier than others at AS Level.

A number of aspects of the present system are based on the assumption that all subjects are of the same standard: league tables; the UCAS tariff; funding mechanisms. Not only is this manifestly untrue but the consistency of the rankings from one year to another demonstrates that nothing is being done by the regulatory authority to rectify the situation. Until this situation changes it is hard to see mathematics numbers returning to a level that is consistent with national needs.

Two types of change are possible.

One is to make serious attempts for consistency across subjects. A simplistic way would involve applying the same pass rate, say 85% of candidates, to all subjects. A more sophisticated version would take account of the ability of the candidates taking the different subjects, for example by referring to their GCSE grades.

An alternative approach would be to accept that some subjects are intrinsically harder than others, and to abandon any attempt to equate them. This would require a change in management philosophy, for example by scrapping league tables.

3.3 *False explanations*

It would be facile to claim that the A Level system is serving universities as well now as it did in the past. It is manifestly not doing so. As has already been explained, the major cause is the reduced uptake of mathematics post-16. However, it is not uncommon to hear incorrect attempts to explain what has gone wrong. The danger is that these are given credence and will then provide the basis of inappropriate changes.

3.3.1 Modular courses

There are those who attribute the present ills to modular courses.

Teaching began on the first modular A Level, MEI Structured Mathematics, in 1990, with first certification in 1992. Its development was a deliberate move to stem the fall-off in A Level numbers and in this it was successful among those who adopted it. The figures in Table 4 show the numbers of AS/A Level students in those schools that opted into the new course in its first year⁴. The figures are shown as a percentage of those for 1991, the last pre-modular year. They show that once the new course had bedded down, there were very large increases.

Year	1991	1992	1993	1994	1995	1996
Uptake	100	107	104	121	149	174

Table 4: Early years uptake of the first modular A Level

In the next few years other mathematics syllabuses followed suit and by 1995 all AS and A Level mathematics had become modular. The downward trend in uptake was reversed and numbers rose in 1996, 1997 and 1998. That was, however, a time of strong complaints about standards and the vicious circle took over, culminating in the large reduction in uptake for 2002 and 2003.

It can safely be said that however bad the present situation may be, it would have been much worse if it were not for modular courses. Furthermore, it is entirely predictable that a reversion to linear syllabuses, which some people would wish to see, would make the situation worse still.

3.3.2 Grading changes

There are also those who attribute the present situation to changes in grading patterns. There is, for example, evidence that candidates who would have been given a grade E in the early 1990s were being awarded C by the end of the decade. This change was actually largely by design. In the past, the distribution of mathematics grades was bimodal with a group on A/B, a large group around E/N and not many in between. There was a deliberate move to right what was widely seen as an injustice. It was recognised that the A Level questions of the time, while mathematically satisfying, were often poor assessment instruments. They provided information about whether candidates could or could not do them, but too often it was all or nothing; they failed to measure how much mathematics candidates knew. Many of those who obtained low grades actually knew quite a lot of mathematics but were not given the opportunity to show it.

3.4 *Current concerns about the single A Level*

The present A Level is still largely an unknown quantity. The first students who set out to take it will only complete in June 2006. (The transition arrangements did allow some candidates to transfer into it in June 2005.) So the “current concerns” described in this section derive at least in part from the Curriculum 2000 syllabus.

3.4.1 The proportion being awarded grade A

A particular current concern is the high proportion of A Level Mathematics candidates being awarded grade A. The figures for mathematics and for all subjects for 2005 are given in Table 5⁵.

Grade	U	E	D	C	B	A
% Mathematics	4.1	6.7	11.3	15.7	21.5	40.7
% All subjects	3.8	9.1	17.2	23.3	23.8	22.8

Table 5: Distribution of A Level grades, 2005

There are several possible explanations for the high proportion of top grades.

- Those who get A deserve it but there is a missing population of candidates who should take mathematics and would fill up the other grades if they did so. Statistical research using GCSE profiles could establish whether those obtaining grade A in mathematics would be expected to obtain the same grade in other subjects, and so probably do deserve their mathematics grade.
- The aggregation system makes it relatively easy to get grade A. By doing well on the easier early modules, candidates can carry a considerable amount of credit towards a grade A through to the harder A2 modules. This means that they can perform well below the standard for an A grade on the later modules but still obtain a grade A overall. This is a particular problem with mathematics where marks well above the A grade threshold are more common than in most other subjects.
- A Level grading generally has got easier as we educate a higher proportion of the cohort post-16, and this includes mathematics.

It is probably the case that all of these are contributory factors. The large number of students with grade A is sometimes seen as a problem by admissions tutors who want to distinguish between stronger and weaker mathematics within that group. Those who experience that need would be best advised to ask for a Further Mathematics grade as well, either at AS Level or at the full A Level.

3.4.2 Fitness for purpose

A more general concern about the single A Level Mathematics is summed up by the catch-phrase “Standards have fallen”. However, many people do not pause to think what this really means. In this context, the word “standard(s)” can take two quite different meanings.

- Standards can be a description of the demands of particular qualifications.
- Standards can also be a statement about the amount that students learn, individually and collectively.

These two meanings can be mutually opposed. Imagine a school athletics programme in which the high jump bar is set at an unrealistic height; the school claims it is setting high standards. However, hardly any students train for the event, knowing that they have no hope of success. The standard of achievement is very low. If, by contrast, the bar had been set at a lower, more realistic level, plenty of students would have trained enthusiastically for it, and the standard of achievement would have been much higher.

Clearly what we want in mathematics, and indeed in education in general, is for standards of achievement to rise. We need to set the difficulty levels of particular examinations so as to achieve that.

The demand of the single A Level Mathematics has unquestionably been reduced with the recent reforms because $\frac{1}{6}$ of the content has been removed. However, most teachers believe that it is now more fit for purpose; taken together with the increases accessibility and availability of Further Mathematics, the change will result in more students taking mathematics post-16 and a consequently increase in the amount of mathematics being learnt.

3.5 Threats

The present A Level syllabus gives definite grounds for optimism but this needs to be tempered by the dangers inherent in a widespread lack of understanding of the processes involved in the vicious circle. It is particularly worrying that many people in positions of influence are unaware of the whole picture.

Two very dangerous ideas are currently being considered.

- A Level Mathematics papers should contain Advanced Extension Award (AEA) style questions⁶.
- A Level Mathematics should be made harder generally⁷.

If either of these were to be implemented, it is entirely predictable that A Level numbers would fall even further.

This is another example of people not seeing the whole picture. If those responsible fully understood the issues, they would never have made these proposals.

4. Constraints related to Further Mathematics

In 2005 Further Mathematics had the greatest percentage increase in uptake (27%) of any subject at AS Level. While this news was very welcome, it is important to be aware of the constraints to the uptake of Further Mathematics and to consider how they can be overcome.

4.1 *Patterns of uptake*

In the past, when the uptake of Further Mathematics was much higher, it used to be quite common practice for schools to offer their students a 3 A Level course consisting only of Physics, Mathematics and Further Mathematics. These days that would be regarded as unacceptably narrow and Further Mathematics is almost invariably a fourth or even fifth subject. However, many students now take 4 or 5 AS Levels in Year 12 and, while most go down to 3 subjects in Year 13, some do carry on with 4 full A Levels. So Further Mathematics is now almost invariably a 4th or 5th subject.

Given this pattern, it is to be expected that the numbers taking AS Further Mathematics will be significantly larger than those taking it as a full A Level. It would be wonderful if the uptake at least at AS Level could be restored to the historical 15 000 mark, but achieving that will almost certainly be dependent on a substantial rise in the numbers taking the single A Level Mathematics.

4.2 *Small numbers of students*

The present small numbers make Further Mathematics classes uneconomical in many schools. By September of this year, this problem will have been solved in England since any school that cannot afford to offer tuition in-house will be able to obtain it for its students through the Further Mathematics Network.

4.3 *Lack of suitable teachers*

Many teachers are not confident at this level. For those who are mathematics graduates, this problem can be overcome by suitable professional development. However, given the general shortage of mathematics teachers, and the need to provide good teaching to younger students, it is likely that there will be a shortage of suitable teachers for the foreseeable future. This problem, too, will be overcome by schools and colleges using the Further Mathematics Network to tutor their students.

4.4 *School administrations*

In some schools and colleges, those in senior management do not understand the importance of Further Mathematics. There are various aspects to this problem.

- Many of those in positions of responsibility have little understanding of the enabling effect that Further Mathematics will have on their students' prospects, and so do not see the point of promoting it.
- There is a widespread, but false, belief that only the most brilliant students will benefit from Further Mathematics.

- There are those who see Further Mathematics as being suitable only for those planning to read mathematics at university and do not understand its importance for science, technology and engineering.

These problems are by no means insuperable; they are the product of ignorance rather than ill will. The government's recent promotion of Further Mathematics is particularly welcome as a step towards changing attitudes.

4.5 University admissions policies

There is widespread agreement in universities that those students who arrive having taken Further Mathematics are much better prepared for their new courses. However, there has until now been a strong reluctance on the part universities even to mention Further Mathematics in their prospectuses, let alone recognise it in their offers.

This has been a serious obstacle to the promotion of Further Mathematics in schools and colleges with senior management saying that there is no point in offering it since universities do not value it.

The universities' reluctance has had a number of related causes.

- They do not want to turn away good students who attended schools that did not offer Further Mathematics.
- They do not want to appear elitist.
- They need to fill their places.

From this September, when the Further Mathematics Network will be fully operational, the first two points will cease to be relevant. Every student in England who would benefit from Further Mathematics will have the opportunity of taking it.

The problem of universities needing to fill their places will, however, remain. Some mathematics departments will be in a position to require Further Mathematics but this will not be generally true across science, technology, and engineering departments. However, it will be in the self-interest of these departments if their admissions procedures make it advantageous for students to have taken Further Mathematics. A simple way to do this is to make a reduced offer elsewhere if it includes Further Mathematics; for example, students could be allowed to drop a grade in one of their 3 A Level subjects if they obtain, say, grade C or better in AS Further Mathematics. This would provide a real incentive for schools to promote Further Mathematics, and so to provide universities with better prepared students.

At present some admissions tutors actually disadvantage students who offer Further Mathematics. It is not uncommon to hear of two students from the same school applying to the same university department with the same 3 main A Levels and receiving the same offer on them; however one of the two students is also taking Further Mathematics and is presented with an additional demand in Further Mathematics, usually a very high grade. Faced with that situation the student is likely to withdraw from Further Mathematics, and the school may well question the wisdom of continuing to offer it.

4.6 *Content*

In the past many schools and colleges found it difficult to stage-manage Further Mathematics teaching because the students had to be accelerated through the A Level work before teaching could begin on any Further Mathematics. That constraint has been removed in the post-Curriculum 2000 measures. AS Further Mathematics has been made into a genuine AS Level, accessible to Year 12 students alongside AS Mathematics, straight after GCSE.

The net effect of this change, and others that have occurred over the years, is that a student who now takes A Level Mathematics and AS Further Mathematics is covering very similar content to one who took A Level Mathematics twenty five years ago.

However, the psychological perspectives of students are quite different. These days they encounter exciting new ideas, like complex numbers, as the building blocks at the start of Further Mathematics whereas in the past they were the last topics in the A Level and were often regarded by students as no more than optional extras.

As has always been the case, those who go on to the full Further Mathematics A Level encounter substantial extra mathematical demands.

5. **The Further Mathematics Network**

5.1 *Origins*

In September 1996, the author gave a presentation to the Leeds Mathematics Teachers Conference entitled “Breaking the Vicious Circle”. It explained how our A Level provision was the subject of a vicious circle, and how it could be rescued by the promotion of Further Mathematics. The Mathematical Association was also publicising the importance of Further Mathematics at that time.

This was a difficult time. The previous year, a new A Level Mathematics syllabus had been introduced but before any students had even completed it, there was a clamour for it to be replaced by something altogether harder. The government of the time had indicated that it would meet these demands and work was about to begin on a new syllabus. (In the event, the new syllabus was prepared but there was a change of government in 1997 and it was put on hold, only to re-surface as the basis of the Curriculum 2000 syllabus.)

About the same time a classroom teacher, Jean Snook, suggested that MEI should investigate and promote ways in which schools could share Further Mathematics teaching.

5.2 *The pilot programme*

It was clear that a significant pilot project was needed if these ideas were to be taken forward. It took some years, and several false attempts, to find the necessary funding. However, towards the end of 1999 the Gatsby Charitable Foundation, who had always been interested in the idea, agreed to support it in full. The following year, Charlie Stripp was appointed and took up post as Programme Leader.

The concept of the pilot project is illustrated in Figure 6.

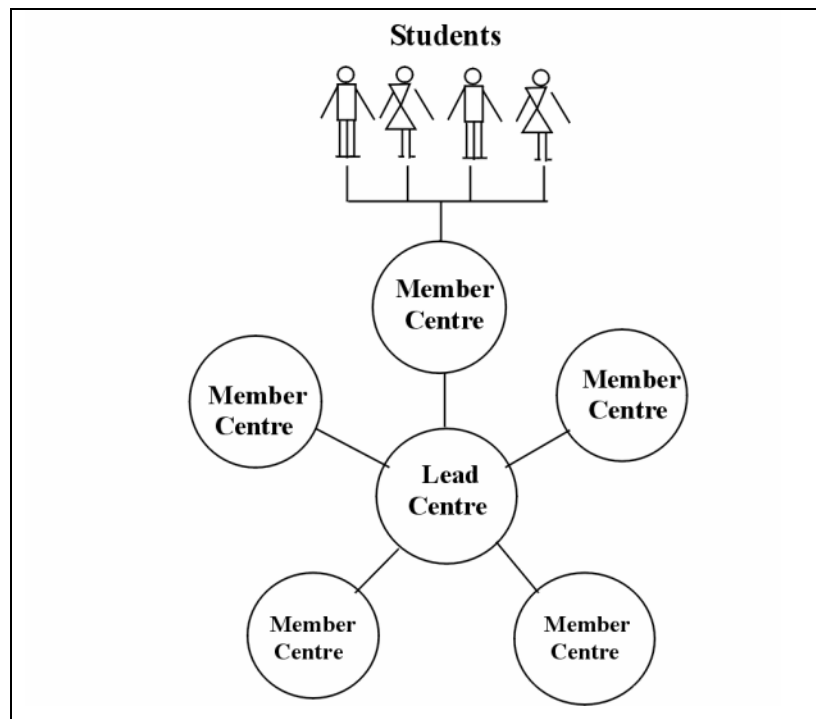


Figure 6: Relationships in the pilot project for the Further Mathematics Network

Tutoring was provided by a Lead Centre to students at local schools and colleges, designated Member Centres. Initially there were two Lead Centres, the University of Warwick and St.Thomas More School in Blaydon. During the course of the pilot other Lead Centres arose so that by the end there were about 10 of them, of various sizes.

The teaching involved a mixture of face-to-face and distant tuition and was supported by a substantial quantity of on-line materials in addition to conventional textbooks.

The main conclusions from the pilot were as follows.

- It is possible to tutor Further Mathematics students very effectively using a mixture of face-to-face and distance learning techniques.
- The best delivery model will depend on local circumstances.
- Students acquire study skills that will really help them at university.
- Schools providing students report improvements in mathematics throughout the age range.
- Many teachers benefit from informal CPD.
- A new Centre has to prove itself locally; for the first two years student numbers will be very small, but will then increase rapidly.
- Students still need moral support in their own schools and colleges.

5.3 *National roll-out*

The project received favourable mention in the Smith report⁸ and, as a result, the government decided to use it as a model to be replicated across the whole of England. This new provision is called the Further Mathematics Network; there will be some 46 Further Mathematics Centres and they will cover the whole country so that every student who would benefit from Further Mathematics has access to it, either in-house or through the local Centre.

At the time of writing this article, 36 of the Centres are running and the remaining 10 are all expected to start during the next term, so that the complete Network will be in operation at the start of the next academic year in September 2006. The Network is being set up and run by MEI on behalf of the DfES, using the expertise built up during the pilot project within an expanded central team, led by Charlie Stripp. It supports all four English A Level specifications.

The Further Mathematics Centres cover larger geographical areas than the pilot Lead Centres, and so they are not single institutions but collaborations, typically involving universities, LEAs, schools and colleges. However, one of the institutions in each Further Mathematics Centre is designated as the Fundholder and is responsible for employing the Centre Manager.

During their early years Centres receive DfES funding. A second source of income comes from schools and colleges; they are funded by the Learning and Skills Council for each qualification for each student, and most of this money is passed on to the Further Mathematics Centres as payment for tuition. The intention is that in the long term the income from the schools and colleges will make the Further Mathematics Centres financially self-sufficient.

5.4 *Making use of the Network*

Until now, nothing in any way like the Further Mathematics Network has existed. It is a new and exciting concept with the potential to transform the situation for all university science, technology, engineering and mathematics departments.

The initial emphasis is obviously on providing Further Mathematics tuition but the Network's activities will inevitably extend much further.

- Further Mathematics Centres will engage with all Further Mathematics students in their areas and not just those they are tutoring, for example by running Study Days, open to all.
- Such activities will often also draw in those doing the single A Level Mathematics.
- Further Mathematics Centres are committed to creating an environment in which (Further) Mathematics will flourish and so will also engage with students in Key Stages 3 & 4, for example by supporting the Additional Mathematics Free Standing Mathematics Qualification, Master classes, etc.
- They will provide CPD opportunities for teachers, as is already happening informally.

There are, however, two ways in which the Network could have a major impact at a much deeper level. Both are related to communication.

5.4.1 Communicating with teachers and students

The Network provides a communication route to all A Level mathematics students and their teachers. The central team are in regular contact with the Centre Managers around the country. They in turn will be in communication with all the A Level providers in their areas; (any institution offering A Level Mathematics is a potential source of Further Mathematics students). Their contacts in those schools and colleges will, of course, pass information on to their colleagues and students. So, it will be possible to disseminate information quickly and efficiently.

At the moment many students do not understand the advantages associated with taking mathematics. They do not know how their career prospects and chances are enhanced, nor do they know how mathematics is used in industry. If these things were better known, students would feel much more motivated to continue with mathematics post-16.

Through the Further Mathematics Network students could receive much better and more accurate information than they do at present. The Network has the potential to make them excited about where their mathematics can take them. To make use of it in this way is a challenge for university science, technology, engineering and mathematics departments, and for those in industry.

5.4.2 Working together

So far about 50 universities are involved in the Further Mathematics Network, actively working with LEAs, schools and colleges; in addition the DfES are watching from a distance with great interest. This means that people and institutions who previously have not worked together are suddenly doing so. The long term outcome from this could be a much better co-ordinated provision in which different sectors and stakeholders understand each others' requirements and also their difficulties.

The vicious circle was able to arise because of a lack of communication between regulatory authorities, universities and schools and colleges. Not enough people saw the whole picture. A consequence of the Further Mathematics Network will be the emergence of a substantial body of people with a much full understanding of curriculum issues. If the Network had been in place ten years ago, the vicious circle would probably never have occurred.

6. In conclusion

There is nothing inevitable about the decline of mathematics in this country but over recent years, it has been seriously damaged. The essential elements are now in place for an altogether better provision.

Let us work together to make it happen.

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Notes and references

1. Exact A Level numbers are surprisingly difficult, perhaps impossible, to determine even for quite recent years. Complicating factors are whether Wales and or Northern Ireland are included, whether the figures refer to candidates or passes and whether Further Mathematics candidates are double-counted.
2. These days examination statistics are published on the web-site of the Joint Council for General Qualifications (JCGQ), www.jcgq.org.uk. Until 2003, Further Mathematics was included with Mathematics and so some candidates were double-counted. The figures for 2004 and 2005 have been adapted so as to continue this practice on the grounds of comparability with the earlier data. Consequently recent figures are about 5000 too large.
3. The information in this table was obtained from the JCGQ web-site. However, over the period in question there has been some redefinition of subjects; for example Irish is now listed as a subject in its own right whereas it used to be included in "Other languages". The figures given here have been adjusted so as to be compatible with the 2001 subject definitions.
4. These figures are contained in the report "MEI Structured Mathematics: 5 years on", K.Porkess, 1996. This report investigated the impact of a modular course, covering the transition from linear to modular. It is the only report of its type, documenting a period that is now becoming a fading memory.
5. These figures were obtained from the JCGQ web-site.
6. The proposal to include AEA-style questions in A Level papers is discussed in some detail in the paper "AEA-style questions in A Level Mathematics papers" which can be found on the MEI web-site, www.mei.org.uk.
7. Both the proposal for AEA style questions in A Level papers and that for harder A Level papers are contained in a speech delivered by the Chief Executive of QCA on 30/3/06. It may be found on the QCA web-site, www.qca.org.uk.
8. Making Mathematics Counts, the report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education, DfES, February 2004.