Qualifications and Curriculum Authority

Evaluation of participation in GCE mathematics

Final report

QCA Research Faculty

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Contents

Summary report

Introduction

This report builds on the *Evaluation of participation in GCE mathematics: Interim report autumn, 2005*[1] to review reaction to the new AS and A level specifications that have been in use since September 2004. The new specifications were a response to points raised by the Qualifications and Curriculum Authority's (QCA) own internal investigations reported in Professor Smith's Post-14 Inquiry [2] on the existing GCE AS and A level (Curriculum 2000) awards. These points included overload and the effect that the Curriculum 2000 awards had on the take-up of mathematics at A level.

The interim report established a number of baseline indicators around take-up and detailed some of the initial responses to the new award. It also began to reveal some of the complexities that exist in mathematics education at all levels, but perhaps most dramatically at A level, in relation to the role of the qualification and its target audience.

This final report reviews the complete evidence base that has been gathered for this study and focuses in particular on some of the fundamental tensions that it reveals.

In our substantial interim report, we reviewed the evidence of take-up of GCE A level mathematics over time, and considered the various possible impacts that the revised specifications may have on student take-up. In considering the evidence surrounding the issue of participation in mathematics, we developed a number of interim hypotheses and baseline indicators that this final report will consider in detail, on the basis of an additional 18 months of data collection.

One of the most interesting things about carrying out this project has been appreciating the wealth of different pressures and perspectives that surround A level mathematics. Finding a way through the contradictions has been a considerable challenge. The team undertaking this work has, rightly, we believe, not been made up of mathematics experts. As we have come to understand the picture, we have come to the realisation that our outsider perspective has enabled us to be able to view the findings neutrally. We have been able to appreciate, and perhaps also to critique, all views.

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[1] This document can be found on the QCA website www.qca.org.uk/qca_10451.aspx
[2] Professor Adrian Smith. *Making mathematics count. The report of Professor Adrian Smith's inquiry into post-14 mathematics education.* Department for Education and Skills (DfES), February 2004.

We have slightly delayed the final report in order to include some additional information to which we did not expect to have such early access. This includes the A level results and matched candidate information for both 2004/5 and for 2005/6 which, together with the 2004/5 information we were able to review in the interim report, gives us a view of three AS cohorts, as well as two A2 years.

In addition, we have been able to squeeze a further online questionnaire into this extended window, enabling us to test our emerging findings over a third year, rather than the original two that were planned. We believe that the ability to provide this significant additional information has provided a great degree of extra value to this report.

As well as these additional sets of data, we have also been able to review some further evidence collected in the context of the 14–19 Reform Programme development work. This relates to the use of resit opportunities in GCE mathematics, and a selection of comparator qualifications. This has helped us explore a little further one of the key emerging themes of this work, the strategic behaviour of students and teachers.

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Summary of key findings and discussion of evidence

It continues to be the case that the further one probes into the area of GCE mathematics, the less straightforward the picture becomes – in almost every corner that we have shone our torch we have found a multiplicity of views and argument.

As we felt in the interim report, the hope that the new qualification would provide a panacea for mathematics cannot be found to be the case. We have discovered positive messages, and have seen what appear to be encouraging trends, for example increases in the proportions of students entering for mathematics at AS and A level. Our online questionnaire respondents have provided evidence of a year-on-year increase in the retention rate of students, with some reports of retention exceeding expectation. We have also heard from some of our case study staff and students that the greater accessibility of mathematics A level is beginning to be spoken about, and so the reputation of its difficulty noted in the interim report may begin to be somewhat diminished. This may pave the way to greater take-up. At the same time, however, we have seen evidence of rising entry requirements for GCE and continued targeted teacher recruitment of high-ability students, and the persistent polarisation of views about the role of mathematics at A level, with high levels of dissatisfaction in some quarters.

Summary of key evidence relating to the new specification

These relate to the central findings from the data in relation to the issue of participation, and also to the hypotheses raised in our interim report.

1. The overall evidence points to an increase in recruitment to mathematics at AS and A2 level and in further mathematics at both AS and A2. This is confirmed both by national statistics about numbers of qualifications achieved, and by our large-scale surveys and case study centres. Several case study teachers reported levels as being ‘back to pre-Curriculum (C2K) 2000 levels’.[3]

2. We have seen continued positive messages about the easing of transition problems from GCSE to A level, with 60 per cent of responding centres agreeing that the new specifications make transition less difficult, rising to over 69 per cent when asked specifically in relation to unit C1.

[3] Provisional data for 2007 from the Joint Council for Qualifications show early indications of a continued growth in take-up of A level mathematics. Although these figures cannot be compared directly with the data discussed in this report, they show a 7 per cent rise in entries between 2006 and 2007. In addition, A level further mathematics shows an 8 per cent rise in the same period.

3. We have seen evidence of better rates of retention from AS to A2 for mathematics, plus a reduction in the proportion of students who were expected to continue to A2 but did not. This evidence comes from our large-scale surveys.

4. Over 45 per cent of respondents to our large-scale survey agreed that spreading the core content over four units has helped students to secure a firmer and clearer understanding of that core material, while only around 16 per cent disagreed with this statement.

5. It was felt by the majority of respondents to our survey (61 per cent) that the two optional units do not provide sufficient ‘stretch’ for most able students. However, some 66 per cent of centres reported offering other strategies to provide additional stretch, including further mathematics, advanced extension awards (AEA) and the sixth-term examination paper (STEP).

6. The change in the balance of the subject areas towards more pure mathematics was cited as the most significant difference between the new and old specifications at A2, and one of the two most significant changes at AS and overall. There was divided opinion about whether this was a positive or negative change when commenting on the changes to AS and overall. However, at A2 it was viewed negatively by the majority of the respondents.

7. The perception that the new specifications were easier was the other most significant difference cited for the AS and overall specifications. Opinion was divided about whether this was a positive or negative change.

8. In the 2006 survey, when asked whether students generally completed their AS in a single year in the 2004/5 academic year, the overwhelming majority of centres (96 per cent) said that they had. A comparison question asking about their practice in 2003/4 showed only 79 per cent completing their AS in a single year.

9. Gender and choice – the evidence gathered since the interim study provided some support from students for the contention that girls placed more emphasis on the importance of feeling able to cope with the demands of the qualification than boys, whereas boys placed more emphasis on the usefulness of the qualification in later life. Teachers were more divided on this issue, and several found it unacceptable ‘stereotyping’. There was little support for stressing different messages in the recruitment of different groups.

10. In terms of targeting a wider group of students, evidence in the interim report suggested that targeted recruitment was at the top end of achievement. We speculated that in order to properly increase participation this would need to become

less exclusive. However, the evidence reviewed in this report suggests an increased focus on the more able cohort, rather than less – both in terms of centre requirements and teacher-targeted recruitment.

11. Increased timetabled time for mathematics A level emerged as a possible route towards increasing achievement and retention. This is based on reports from centres that their most successful strategies had involved building in additional time. Reviewing centre time allocations showed that in almost all cases, centres allocate the same amount of time to mathematics as for other A levels, with this sometimes being shared between mathematics and further mathematics provision.

12. We speculated in the interim report that evidence of a widening of participation was likely to be seen in more democratic grade distribution and GCSE point score – in reviewing the information from 2005/6, there is no evidence of a shift in the make-up of the cohort in terms of average GCSE point score. Also the grades achieved do not appear to have become any less 'top heavy' with continued growth in the proportion of students achieving A grades. As with all these data it is too soon to be talking of established trends, with only one year's data for the full A level award, and continued monitoring is necessary.

13. We also predicted that conversion rates from AS to A level should improve if the qualification was more accessible and seen to be so by students progressing. The recent data does not show a consistent trend, with one year showing an increase and the following a decrease in rates. However, this has to be seen in the context of the overall increase in student numbers both at AS and A2 level. There is evidence, however, from the large-scale surveys, that does appear to indicate an upward trend in terms of the proportions of those who originally intend to complete the A level staying on after AS.

14. We expected to see less negative perception of mathematics A level amongst students if the new qualification was proving to be more accessible – and there is some evidence of this from interviews with case study schools in both teacher and student evidence.

Discussion of evidence and key themes

As we have moved to a position where we have been able to review a larger collection of evidence from a more diverse group of sources, we have also been able to identify a number of overarching issues that we feel indicates a need for some fundamental review and discussion of the current situation in order to move forward positively.

In considering our conclusions, we need to refer back to our starting point. Smith's report formed the basis for this project, and although the central focus for our study was the issue of participation, which appears relatively simple, it is worth reviewing several of Smith's findings. These, taken together, start to illustrate some of the complexities in this area. The following paragraphs are drawn from the Smith report:

> '… respondents have also wished to challenge the current arrangement whereby GCE mathematics attracts the same UCAS tariff as any other GCE at either AS or A level. This is seen as unhelpful on two counts. First, there is clear evidence that mathematics does not present a level playing field in terms of attaining grades and a clear perception that mathematics is hard. It is argued that an incentive is needed to counteract this. Secondly, mathematics is unique in providing the key underpinning of so many other disciplines. It is argued that this needs to be formally recognised in order to encourage greater involvement with mathematics post-16. Para 4.35 p. 93.
>
> … in terms of students' and teachers' perception of the subject, many respondents believe that, for other than the mathematically clearly very able students, there is a tendency for schools to see choosing mathematics A level as higher risk in terms of outcome than many other disciplines. To add to this perception, it is clear that many weak students do not complete the course in GCE mathematics and many of those who do complete are not classified on their examination performance. At the other end of the scale, A level mathematics is felt not to discriminate sufficiently amongst those awarded the highest grades in the subject. Para 4.37 p. 94.
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> … in addition to the anxiety referred to above about the undesirable effects of the current arrangements for the lower attaining 30 per cent of the age cohort, respondents to the Inquiry have expressed considerable concern that we do not sufficiently stretch and motivate the top 10 per cent. The Inquiry agrees and believes it to be vitally important that we nurture and encourage the very best mathematical talent. The Inquiry therefore recommends that attention be given to making special provision in mathematics for these more able pupils, both at GCSE and GCE levels. Para 29 p. 7.
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> … during 2000/01, serious difficulties with AS mathematics were reported to the regulatory authorities. The overriding concern of teachers was that AS mathematics appeared to be too difficult and was turning many students away from the subject. The results of the first cohort of candidates appeared to confirm this. The pass rate amongst the 17-year-old cohort was 71.8 per cent, very low compared to other mainstream subjects like English, history, geography, physics, chemistry and biology. Although in subsequent years the AS pass rate in mathematics had increased, it still remains conspicuously out of line with other mainstream subjects. Para 3.23 p. 60.'

These paragraphs, when reviewed as a whole, indicate several contradictory needs. There is a call for the UCAS tariff to recognise that mathematics is harder than other subjects, yet at the same time there are recommendations that it be brought into line with other mainstream subjects. There is also contained a recognition that some mathematics underpins a wide range of other subjects, so is of benefit to more than just the mathematically very able, yet the new qualification needs to go further in stretching and motivating the highest of achievers. The contradicting aims and wishes contained within these paragraphs are writ small and large throughout all the evidence that we have gathered and reviewed during this project.

Where we have been able to find clear directions of change in the evidence, we have almost always also been able to point to a division of opinion in terms of how these changes should be viewed, for example as we said in our interim report, the move to less content in the qualification has been recognised by almost all, and welcomed as increasing accessibility. On the whole, however, there has also been a substantial minority who have viewed this as unacceptable and an erosion of the subject. We have felt, therefore, that as well as looking at the relatively simple issue of whether there has been an increase in participation, we ought to look at some of the underpinning contradictions and problems in relation to three broad themes raised in the review of the paragraphs from Smith quoted above:

1. Is the new qualification easier than the last?
2. Is the new qualification leading to higher levels of participation?
3. Is the new qualification providing greater stretch for the most able?

Is the new qualification easier than the last?

In reviewing the evidence relating to the 'ease' or 'difficulty' of the new qualification, it is necessary to ask what the A level in mathematics comprises and the different routes by which it can be achieved.

In our research we identified a theme of uncertainty about what constituted GCE mathematics. This stems from:

- the level of flexibility in the current GCE mathematics and further mathematics qualifications
- the level of strategic choice available
- the amount of unit resitting.

The level of flexibility in the current GCE mathematics and further mathematics qualifications

There is some perception of confusion around where the standard lies in mathematics, chiefly because of the potential breadth of difference between the programmes of study followed by different students. These concerns are felt by some sectors of higher education, as well as by teachers themselves.

A review of the national performance tables for mathematics, even using matched candidate information, cannot provide a sufficiently detailed picture of the reality of mathematics' achievement, simply because of the variety of outcomes that this 'single' award allows for. The design of the current A level mathematics qualification requires students to take four core units (two AS and two A2) plus two other units to complete the award. These two units may either be two different AS units or one AS and one A2 unit. The choice of units falls within three families: decision, statistics and mechanics. In each family there are two units, one AS and one A2. For those choosing to do two AS units to complete their A level, the units are necessarily from different families, for those choosing one AS and one A2, the units must be from the same family.

In effect, therefore, there are six possible A level mathematics qualifications, as follows:

Table 1. Six possible A level mathematics qualifications

Award	Mandatory content	Optional unit content
1	Core 1–4	Mechanics M1 (AS) Mechanics M2 (A2)
2	Core 1–4	Statistics S1 (AS) Statistics S2 (A2)
3	Core 1–4	Decision mathematics D1 (AS) Decision mathematics D2 (A2)
4	Core 1–4	Mechanics M1 (AS) Statistics S1 (AS)
5	Core 1–4	Statistics S1 (AS) Decision mathematics D1 (AS)
6	Core 1–4	Mechanics M1 (AS) Decision mathematics D1 (AS)

Opinion varies about whether these represent a similar level of difficulty, or a comparable coverage of mathematics. However, evidence from this study indicates a significant amount of 'strategic' selection of optional units by centres and an informal straw poll of experts[4] carried out for this study returned a unanimous view that M1 and M2 represented the most challenging combination, and that S1 and D1 would be likely to be seen as the easiest. A review of the proportions of A grades achieved by candidates in the Edexcel mathematics A level in summer 2006 is interesting in the light of these views.

[4] Composed of QCA and awarding body subject experts plus some experienced A level teachers.

Table 2. Edexcel notional results by AS/A2 unit combination[5]

No	Possible AS/A2 unit combination	Optional unit content	A grade (%)	No. total cands	Total cands (%)
1	3 AS and 3 A2	Mechanics M1 (AS) Mechanics M2 (A2)	52.5	4,328	21.8
2	4 AS and 2 A2	Statistics S1 (AS) Statistics S2 (A2)	42.2	4,012	20.2
3	3 AS and 3 A2	Decision mathematics D1 (AS) Decision mathematics D2 (A2)	42.6	190	1.0
4	4 AS and 2 A2	Mechanics M1 (AS) Statistics S1 (AS)	47.1	8,970	45.1
5	4 AS and 2 A2	Statistics S1 (AS) Decision mathematics D1 (AS)	37.8	1,433	7.2
6	4 AS and 2 A2	Mechanics M1 (AS) Decision mathematics D1 (AS)	50.1	944	4.7
				19,877	100

These results show a striking difference in the profile of A grades in respect of the two combinations cited. The S1, D1 ('easiest') combination has the lowest proportion of A grades, whereas M1, M2 ('hardest') has the highest. Since awarding body analysis of matched candidate data shows comparable performance across all combinations in terms of prior attainment, the most likely explanation for this pattern of results would be that more of the most able students are taking M1, M2, and more of the less able students are taking the S1, D1 combination. It is notable combinations including D units are taken by a considerably lower volume of students, decision mathematics is a newer topic in the A level, and not one that all teachers are comfortable with. However, AQA report growing numbers of students taking the decision mathematics units.

The most popular combination of units is M1 with S1, with over twice as many students taking this combination as the next most popular.

When questioned about choices in terms of the A level units that were offered by case study centres, staff reported that D1 and D2 were more appealing to less able mathematicians, and that some centres were offering only AS optional units – partly to maximise results and partly to provide solid foundations for learning.

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[5] The evidence described here relates to candidates who were 16 years old by September 1 2004 who had gained a complete set of unit results. Units had to be achieved during the four assessment opportunities leading up to summer 2006 results.

Notional student results were calculated on the basis of unit achievement, whether or not they 'cashed-in' their results. For mathematics students the calculations were made on the basis of the six best unit grades, disregarding any relationship to further mathematics. Thus, the least-best rule did not operate in these calculated results. See Appendices B&C for further details.

A further level of complexity comes into play for students who also take either an AS or A level in further mathematics. To complete a further mathematics A level, the students must take further pure mathematics 1 (FP1), plus an A2 FP unit and then have four optional units. The optional units that may be taken include all of the optional units in the A level mathematics qualification as well as the further mathematics-specific suite. There is a high degree of unit sharing between the two awards, which is compounded by an unusual interdependent awarding process for students who have completed awards in both mathematics and further mathematics.

The awarding for these students is based on the principle of 'least best' grade and works in the following way: students are awarded the highest overall grade possible for their A level mathematics, but if there is a way of achieving this grade using more than one combination of eligible units (those shared between the two awards) then the process allocates the 'least best' combination to the A level (for example if the student is carrying six A grades and a B grade that could feasibly be used towards the A level award, the calculation will be made to use five A grades and the B grade for the A level mathematics, and carry the extra A grade forward to the further mathematics qualification).

This process is a unique one and can result in strange outcomes. A class of students that has sat in the same lessons at the same time may actually achieve their A level mathematics results based on different units because of the impact of the 'least-best' rule on the results of those who also achieved further mathematics.

In a recent piece of work carried out for QCA by UCAS, about the possible use of unit grade information by higher education admissions tutors, there were some particularly interesting findings in relation to mathematics. The majority of the higher education institutions represented was from the Russell Group. Speaking about entry into highly selective courses they advised that they would be generally unlikely to make conditional offers based on achievement at unit level, but may do so in relation to key specified mathematics units. 'They reported an interest in knowing which units of AS and A level mathematics and further mathematics had been taken or were being taken, given the amount of *choice* within these qualifications. Effectively, this would tell them what type of mathematician the applicant was and their suitability for progression, for example mechanics units for engineering, and potentially highlighted any relevant weaknesses.' [6]

[6] UCAS report for QCA, *Investigation into the use of unit grade information amongst UCAS pilot institutions for 2006 entry and selected schools and colleges*, (unpublished) June 2007.

The level of strategic choice available

Reviewing this discussion so far, it is alarming in several respects. First, that it seems to be possible for teachers and experts to agree that certain combinations are more or less easy than others, and secondly – predictably, given this first point – there appears to be some level of strategic thinking about which combinations of units to offer.

The outcome is that students taking one route rather than another may have quite a different experience of mathematics, and may have covered a substantially different area of knowledge, skills and understanding. The emphasis placed by the higher education admissions tutors on the ‘amount of choice’ in the mathematics qualifications and that this may tell them about the suitability of the applicant for progression implies that this choice is made at the level of the student. However, both centres and students often report a lack of choice being offered, generally due to resources available at the centre.

Although there is a breadth of units available in theory at A level mathematics, the actual choice available to students is restricted – either to what a teacher may feel the student can manage or to what the school or college can afford to offer. The issue of strategy in terms of the selection of units that make up the qualification is nearly always decided at centre rather than student level.

It is important also to recognise that the apparent degree of choice appears largely to be a chimera. First, in some centres there is no choice at all for students about what units they can take, and secondly, for some students – taking the further mathematics – they may end up with combinations of units in each of their mathematics A levels that were not the programme of study that they followed through the ‘least best’ awarding process.

This variation in possible range of study, or recorded achievement, becomes suddenly more important when viewed through the eyes of those who will make decisions about which students to accept for further study. Looking at the discussion of the higher education institutions there is an assumption that there is a ‘choice’ of units that is open to the students, which we have already seen is often at best at the level of the institution, rather than at the level of the student. Furthermore, based on this assumption, they may in the future begin to make distinctions between students who achieve different combinations of units.

Even if the universities do not look at the actual units a student takes, referring to unit grade profiles alone may be to the detriment of some students who have been awarded their A level grades on the basis of the ‘least best’ process since their A level mathematics unit grades may not look as impressive as they might. Bearing in mind that higher education institutions often state that they do not ‘require’ further mathematics because it is not available to all students, using A level grades as a common reference point may be detrimental to the further mathematician.

The recent development of the Further Mathematics Network means that further mathematics is being widely promoted and take-up has increased very significantly.[7] It also means, in theory, that further mathematics is available to all students with support available to teachers. However, despite over 1200 schools and colleges having registered with the Further Mathematics Network, the evidence in this study suggests that knowledge about the network and take-up of further mathematics via this route is still patchy. Further work should be carried out to ensure that there is, in practical terms, universal and equal access to further mathematics, and that it would be appropriate for higher education tutors to use achievement in further mathematics as a legitimate discriminator.

The amount of unit resitting

The final structural area that has an impact on the students’ final achievement is resitting of unit assessment. In the review of evidence discussed in sections ‘Participation and achievement’ and ‘Reactions to new specifications’, there is a comparison of the prevalence of resitting between mathematics and other comparator subjects, as well as a review of the evidence about resitting behaviour from the large-scale questionnaire that was administered in 2007. In summary, mathematics has amongst the highest level of resitting on at least one occasion across the most units. Mathematics sees relatively high proportions of resits over at least four units in a qualification in all unit combinations. Furthermore, it also shows the most persistent resitting, with the highest proportion of candidates repeatedly resitting units. It also shows some of the highest ‘returns’ to resitting with candidates gaining considerable grade improvement.

The average improvement in the proportion of A grades as a result of resitting is shown in Table 3 for all unit combinations. The table shows what the A level result would have been using the AS grades achieved by summer 2005, and the actual A level result achieved by summer 2006. The M1, S1 combination is the largest entry group, and the percentage of A grades rose from 39.3 per cent to 47.1 per cent.

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[7] Appendix A shows evidence in relation to matched cohort data for 18-year-olds, see also http://www.fmnetwork.org.uk/manager_area/files/1analysisofFMNimpact.pdf for JCQ data for examination/entry results for all candidates 2002–7

Table 3. Returns to resitting – Edexcel A level mathematics, summer 2006[8]

No	Optional unit content	A grade A levels (%) using summer 2005 AS grades	A grade A levels (%) using summer 2006 AS grades	Change (% points)
1	M1 M2 (1 AS 1 A2)	46.6	52.5	+5.9
2	S1 S2 (1 AS 1 A2)	35.1	42.2	+7.1
3	D1 D2 (1 AS 1 A2)	34.2	42.6	+8.4
4	M1 S1(2 AS)	39.3	47.1	+7.8
5	S1 D1(2 AS)	32.8	37.8	+5.0
6	M1 D1(2 AS)	43.5	51.1	+7.6

When discussed with case study teachers, it was felt that students act strategically, retaking the easier, early units. This was echoed by our large-scale questionnaire respondents, most of whom indicated that the majority of resitting behaviour related to A level students resitting AS units, with around 30 per cent of centres indicating that between 71 and 100 per cent of their students resat units. Forty per cent of centres, when asked what type of student took resits, replied 'all students'. The most popular reason given for resitting AS units was 'maximising grade for A level qualification', given by 66 per cent of respondents.

The qualitative evidence reinforces the picture drawn by the awarding body statistics described above, and also indicates the type of strategic behaviour that takes place in respect of resitting. Given the benefits that accrue to student grades it is not surprising that this happens. It is interesting to note that the same higher education tutors who were interested in finding out more about which units students had achieved, also expressed interest in seeing whether students had resat units.

It is true for all subjects that there are benefits to retaking, but overall these are greater for mathematics than for other subjects. A level mathematics, given the spiral curriculum and the very nature of the subject, reinforces earlier learning later in the programme, so students are very likely to perform more highly in the earlier units if retaken later in the programme when the student has progressed. In other subjects, where areas of performance are more discrete, this is less likely to be the case.

Summary

The evidence discussed above about whether the new qualification is easier has not broached the issue of whether the overall content is more or less easy than previous mathematics qualifications. Rather it has looked at the stability of the level of demand within the award as a key issue, since whether there is an absolute benchmark that can

[8] Note that these figures relate only to candidates who were 16 years old by 1 September 2004.

be placed on the demand – and where that lies – is essential in order to discuss equivalence.

The apparently fungible nature of the current mathematics award, where there are in effect six different qualifications encapsulated within the same title, relies on all of these being of equal demand, preparing students equally for progression. However, the evidence suggests that this is not perceived to be the case by those offering the award or selecting students for progression. Further, the amount of repeated assessment taking place, with students 'maximising' their achievement on the less demanding units, can also be seen to somewhat colour the issues around accessibility or ease. This, of course, was not an issue that arose in the context of linear awards.

Recommendation

It appears that, at the very least, a relatively straightforward change could be made to simplify the situation by formally separating the requirements for an A level in mathematics and an A level in further mathematics. By designating particular units to each award, the peculiar 'least best' relationship would be severed, and there would be more clarity both for the student and those choosing between students about what is being studied for each award.

Any further work to amend the perceived variability of demand of the various components of the current offer may need to be considered in terms of the intended target group of students.

The relative 'ease' of the new award, in terms of changes to content since the Curriculum 2000 version, is discussed at some length in the sections below. It is clear from case study and questionnaire evidence that there has been a slimming-down of content – the next thorny issue to discuss is whether this is judged to be something that is appropriate for A level mathematics.

This provides the context for both of the remaining themes for discussion, both of which centre on judgements around the function of mathematics and which will be considered together.

Is the new qualification leading to higher levels of participation?

As highlighted in the summary above, and in detail in discussion of evidence below, there are now higher numbers entering for the A level mathematics qualification. The issue to be discussed within this section is not whether there are more students participating, but who these students should be and is a higher level of participation sufficient if it is not a widening level at the same time.

The ‘Smith paradox’ in this section is the issue of the A level being designed both for those who need mathematics as an underpinning for other areas of study and for those who are able mathematicians who will progress. The current position, as identified in the previous interim report, and confirmed by the review of national data in this report, is that mathematics students are a highly achieving sub-group of A level students. The issue, then, is whether we are content for this to continue to be the case? Are we content to draw in more high achievers to study mathematics – increasing the clever core? Or is the discussion relating to providing a more accessible qualification one that implies that mathematics at A level should be embracing a broader range of ability, more in line with other A levels?

Reviewing the evidence collected for this study we have seen a continued split in views of the new qualifications – the persistence of two main points of view, one that the qualification is more accessible, more like other A levels and therefore this is a good thing; the alternative view is that the A level is easier, not like it used to be, no longer stretching very able students and this is a bad thing.

In discussing this issue there are two points for consideration:

- Who is achieving A level mathematics?
- Why are others not achieving A level mathematics?

Who is achieving A level mathematics?

We have seen continued support for the clever core hypothesis raised in our interim report, both in our own evidence and supported by Bell and Emery.[9] There has been no democratisation of the award in terms of the matched candidate data, and there has been no downturn in the previous GCSE point score for A level mathematicians or an equivalent upturn in other subjects’ scores. In our interim report we contended that we needed to look beyond the clever core if there was to be a large increase in students taking part in mathematics at A level – our argument was based on a high average GCSE point score. Bell and Emery found, in addition, that 85 per cent of successful A level mathematicians have either an A or A* at GCSE in mathematics which ‘although comparable with French at 93 per cent or sciences at 80 per cent this is much higher than subjects such as English (50 per cent) and history (49 per cent)’. It is true to say that

[9] John F Bell and Joanne Emery. *The curious case of the disappearing mathematicians, Research Matters*, Research Division Cambridge Assessment, June 2006.

these high GCSE scores, whether average or mathematics-specific, are followed by a subsequently very high proportion of A grades at A level.

The data on A level achievement, compared with AS achievement in mathematics, is interesting. Reviewing the results of AS in 2005 and A level in 2006 we see A–E achievement of 86.4 per cent in 2005 at AS, compared with 97.1 per cent in 2006 at A level, and 34.4 per cent A grades at AS in 2005 compared with 45.3 per cent at A level in 2006. This is a higher 'raising of the bar' in this period than seen in comparison subjects. Part of this may be explained by the benefit of resitting in the second year, but it is worth bearing in mind that AS grades are tempered by the effect of the 'A2' portion of the full A level results. But it is also the case that, looking at the GCSE point score for those taking only an AS in mathematics, and A levels in other subjects (as when taken as the fourth AS), we see a greater disparity between the AS and A level cohorts' GCSE point scores than for any of the other subjects – a change of +0.5, changes in the other comparator subjects are between 0 and +0.2 points, except for physics which shows a +0.4 gain. This is a clear indication of AS being a 'stepping off' point for the less able students, which does not happen to the same extent in other subjects. It must be borne in mind, of course, that even at AS level, AS mathematics students show the joint highest average GCSE point score of all comparator subjects.

Why are others not achieving A level mathematics?

In this section the evidence about how students are selected for A level mathematics is considered, in terms of possible explanations for the profile of student that we see.

The evidence from both case study schools and the large-scale questionnaires reviewed in the section 'Student choice of mathematics' indicates some movement over the course of this project to higher entry requirements for A level mathematics, accompanied by an increase in the proportion of schools and colleges targeting only higher tier GCSE candidates. In fact this targeting is reported more frequently than the 'requirement' for a higher tier grade as a formal requirement. In the period where we have some agreement that the content of the new award is more accessible (for good or ill) than previously, we have also seen an increase in the entry requirement, which is apparently reinforced by a tendency on the part of teachers to 'recruit up'.

It seems valid then to consider the implications that this 'top end' recruitment may have on teaching and learning. The available evidence suggests that there is likely to be a large proportion of high achievers in most A level mathematics groups, and it is legitimate to ask whether, because of this, teaching methods may be aimed more at stretching the majority who are able, than at other students who may be more modestly successful? We have some evidence from the centre visit discussions with students who did not complete their mathematics A level, these made reference to being ‘left behind’, and had found AS difficult because of high workload, fast pace and amount of work outside of lessons. This had led to students getting behind or having to devote a disproportionate amount of time to it. Over half of students dropping mathematics at A level said that they felt that different teaching methods could have helped them to continue. They suggested that better explanations from teachers, smaller groups and a slower pace of work for the less able could all help with retention.

It may be that the big change in cohort composition between AS and A2 level, with students with lower average point scores leaving their courses could partly be explained by this type of experience. This ‘weeding out’ does not happen to the same extent in other subjects – first the initial selection of students is not at such a high level, and then the cull of students between the awards is not so ruthless (they retain a more similar GCSE point score at AS and A level). The model, based on these outward signals, appears based on the premise of ‘including out’ those who will not excel, rather than supporting those who choose the subject. It would not be true to suggest that this is a deliberate weeding out by teachers, but rather may be a self-selected weeding out by students who do not feel sufficiently well supported to continue.

It is interesting that the issues described by students who did not complete their qualification, such as needing better explanations, are raised in the Ofsted report *Evaluating mathematics provision for 14–19 year olds*,[10] which found that mathematics teaching, although it was often well targeted to produce good examinations results, was not succeeding as well in promoting a really secure understanding of mathematical ideas, in stimulating students to think for themselves and to apply their knowledge and skills in unfamiliar situations. This suggests that improvements in teaching and learning need to be targeted at these more vulnerable students.

Summary

Although more students are now taking A level mathematics, they tend to be recruited from a clever core of students with relatively high levels of prior attainment. The high or increased entry requirements at centre level and targeted recruitment of students may be a factor in the perpetuation of this clever core. Furthermore, the end of AS appears to be more of a ‘stepping off’ point for lower attaining students than in other subjects. It may be that teaching methods are more geared towards stretching the able majority, with the result that some students feel left behind and decide not to continue beyond AS.

[10] Ofsted, *Evaluating mathematics provision for 14–19 year olds*, May 2006.

Recommendation

The issue of whether A level teaching is geared to the right level to encourage participation and achievement by students who are not high-flyers is something that may merit further investigation. It also needs to be considered in terms of teachers' conceptualisations of mathematics A level's ability to challenge those who are more able.

Is the new qualification providing greater stretch for the most able?

It is interesting to note that the majority of respondents to the large-scale survey did not think that the current A level was sufficiently stretching for the most able. This theme is an interesting one since it brings into question whether, given the highly achieving make-up of the top end of the A level mathematics cohort, an A level that is at all comparable with other A levels in terms of level of demand is ever likely to be able to fully stretch the most able students.

A particularly interesting part of the student evidence that has been reviewed relates to their opinions about the relative difficulty or ease of mathematics. Although many students rate mathematics as the most difficult subject they study, and it has a reputation of being more difficult than other A levels more generally, there is a reasonably large proportion of students who consider it to be their easiest subject. In addition, there are quite large numbers of students who, in the same time – or only slightly more – as is allocated to other A levels, manage to complete both an A level in mathematics and an AS or A level in further mathematics, and achieve high grades on both awards. This raises the very complex question, which cannot be answered here, if anywhere, about what constitutes 'absolute difficulty'.

Case study evidence includes teachers' descriptions of the 'flair of the really able' that a 'slogger' would never have. There is, by some teachers, an apparent acceptance of mathematically gifted students being somehow different to those who 'try', and can achieve quite well. This evidence may suggest a conceptualisation by some teachers of students as falling into one of two camps – gifted or not, rather than along a spectrum of ability. This may be something that deserves further investigation, first to confirm and, secondly, if it was seen to exist, to measure its prevalence. It is likely that a widespread tendency to see students as either mathematically 'very able' or not may not be helpful in terms of trying to increase mathematical performance across the whole cohort.

It is also interesting to speculate whether teachers who – by definition – are likely to be gifted at mathematics are adequately prepared to understand the needs of those who require more support in order to achieve, particularly in the context of A level where students are choosing to continue with the subject and may be expected to have an interest, if not ‘flair’ in it. This relates back to the issue discussed above about whether some teachers are engaging equally appropriately with all students, or whether there may possibly be some unconscious favouring of ‘like minds’.

Summary

In considering the discussion relating to this theme, there appears to be conflict about whether it is possible to meet the range of needs for this qualification, and whether it is wise to try to do so. It is clear that there are students who are being ‘turned off’ mathematics by their experience of AS, whether because they fail at this level or because their AS experience discourages them. Since these students are apparently in the lower range of achievement, it appears that, for all that the current GCE is being seen as ‘easier’ than its predecessor, it is not so far operating as a more ‘accessible’ qualification – with gatekeepers raising the bar in terms of student entry requirements.

In some ways, the changes to the design of the award that have been made to encourage success, perhaps particularly of those who need it to provide what Smith described as ‘key underpinning’ to other disciplines, are not being experienced by their intended targets. If there was an intention to ‘widen’ participation to include a more ‘normal’ profile of achievement, this has not succeeded. The qualification remains exclusive.

This may not be a problem. Case study centres reported that the potential clever core is larger than the numbers they currently recruit to mathematics and it is possible just to find more clever students and so perhaps there is no need to worry about engagement beyond this group. We have seen this pattern emerging in the longitudinal statistics, with more, more able, candidates achieving. It may be that those students who were put off the A level mathematics award by its reputation as more difficult compared with other A levels, in terms of providing a good grade, have been reassured by the recent changes.

There is then a serious question for mathematics A level. Are we happy to have fewer but stronger mathematics experts, which would reflect the current strategies of recruitment and retention? If so, we should reconsider the design of the A level with this in mind so that it reflected the requirements of this group. Or do we want to have more people learning mathematics to a higher level? If the answer to this second question is yes, then the way forward must be to recognise that the needs of both groups – to stretch and to include – cannot be met within a single award.

It is necessary to seriously consider whether, for the extremely able sub-group of students who currently take A level mathematics, there needs to be some supplementary provision that takes the standard of achievement beyond A level.

The current position, of an intertwined and interchangeable profile of provision across A level mathematics and further mathematics, does not seem properly geared to provide the necessary differentiation.

It is likely that some consideration needs to be given to a clear statement about the purposes and expectations of mathematics provision at A level, so that there is less division of opinion between those delivering the award, and recruiting on from the award, about how far it is fit for its purpose.

Recommendation

Depending on the answer to this, there are two choices:

- develop a qualification that meets the needs of the clever core accepting that you are building an exclusive route
- revise the A level to be a qualification that is well aligned to the demands of other A levels, but design some form of supplementary stretching qualification that is accessible only to very able mathematicians; this, of course, raises the issue of what level this new qualification should be pitched at, since it seems unlikely that it could be easily encompassed within ‘A level’.

Overview of related work

This evaluation was undertaken in response to the issues raised by Professor Adrian Smith's report in February 2004, which itself built on the findings of Sir Gareth Roberts' report of April 2002.[11] The findings of this report will inform a number of areas of QCA activity in respect of mathematics, some of which are described below.

The Smith report resulted in a number of different areas of research and development work being instigated by the then Department for Education and Skills (DfES), and undertaken by QCA. Following piloting and evaluation, the two-tier GCSE in mathematics, which gives all candidates the opportunity to achieve a grade C, was introduced for first teaching in September 2006. In line with recommendations from the QCA consultation on coursework in GCSE mathematics, from September 2007 the GCSE in mathematics without coursework will commence teaching.

The Smith report also recommended an investigation of the feasibility of making GCSE mathematics either a double award (like science) or two single awards (like English language and literature). Two investigations are now underway into two separate GCSEs in mathematics. In England, two GCSEs – based on the revised key stage 4 programme of study that is designed to be available to all candidates, are being piloted (2007-2010). One has the assessment of functional mathematics embedded and the second focuses on problem solving and process skills in mathematics. Northern Ireland already offers a second GCSE based on additional content aimed at higher attainers, and Wales is investigating a similar second GCSE.

In response to Smith's findings about the lack of properly qualified mathematics teachers, the Department for Children, Schools and Families (DCSF) is taking steps to increase the supply of qualified teachers of mathematics. For example the Training and Development Agency for Schools (TDA) is piloting courses aimed at enhancing secondary school non-specialists' knowledge and understanding of mathematics directly related to classroom practice. It is worth noting that all staff teaching GCE mathematics in the case study centres in this study were specialist, qualified mathematicians. It is likely that, because of the level of knowledge required at GCE level, Smith's comments relate particularly to the teaching of learners working below GCE level.

As this study discusses at some length, Smith also stressed the importance of ensuring that there is sufficiently stretching material to provide a challenge to those students who

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[11] Sir Gareth Roberts, *SET for success: the supply of people with science, technology, engineering and mathematics skills*, Exchequer, April 2002.

are very able at mathematics, both in GCSE and GCE. QCA's post-14 mathematics work is considering whether changes are needed to the structure and assessment of GCSE and GCE mathematics, and whether there should be a greater emphasis on an extension curriculum for students in key stage 4 and beyond. One specific issue relates to whether a more efficient way can be found to replace the AEA, designed for the most able GCE students. The then DfES funded the Further Mathematics Network, the principal aims of which are to make further mathematics available to all potential candidates and to provide support for teachers through materials and training. It is noted in the report that many teachers make further mathematics available as a way of stretching and challenging their higher attaining students.

Concern was raised in the Smith inquiry about the nature and frequency of assessment in the AS/A2 structure of six-unit GCEs. Most GCE subjects are now moving to a four-unit structure and, in mathematics, QCA's post-14 mathematics Pathways project contractors are piloting and trialling four-unit A level mathematics, and one is looking at a four-unit A level in further mathematics. One of these models involves some statistics and mechanics at AS level and just one optional unit at A2. QCA will make recommendations for the future of GCE mathematics, with first teaching from 2011.

MoreMathsGrads is another initiative that is currently underway and is of interest to this project. It is being carried out and funded by the Higher Education Funding Council for England (HEFCE). Its focus is to prepare a strategy to improve the uptake of courses in mathematical sciences and in mathematics-related courses in higher education. The initiative has influential sponsors including the Institute of Mathematics and its Applications (IMA), the Royal Statistical Society (RSS), and Heads of Departments of Mathematical Sciences in the UK (HoDoMS).

Findings and discussion

Sources

QCA's evaluation of GCE A level mathematics draws on a number of different sources of evidence. The main ones are national examinations data, a large-scale questionnaire and a sample of case study centres involving teaching staff and students to provide a comprehensive picture of take-up and participation in mathematics at A level. These are described in some detail below. In addition, we have reviewed awarding body evidence of resitting behaviour both in mathematics and a number of comparison subjects, and evidence from a report by UCAS about the use of unit grade information by higher education institutions.[12]

Matched candidate results analysis

This provides a picture of the take-up of GCE mathematics both before the Curriculum 2000 specifications were introduced, and during Curriculum 2000 implementation providing an assessment of the impact of Curriculum 2000 and a baseline for the new GCE mathematics specification. They are based on matched candidate data. This means that there is information at student level about previous performance in GCSE examinations, as well as in other GCE awards.

Figures are analysed in relation to the national cohort and AS and A level cohorts, to provide a comprehensive picture of the proportions of young people taking mathematics AS and A level awards over time.

The data relate to the following years.

Table 4. A and AS level data from 2001–6

2001	Legacy A level	C2K AS	
2002		C2K AS	C2K A level
2003		C2K AS	C2K A level
2004		C2K AS	C2K A level
2005		C2K AS	C2K A level
2006		C2K AS	C2K A level

In addition to information about mathematics, data about English, physics and geography was included in the interim report to provide a point of reference and comparison. In addition, this report includes figures for media and psychology to provide further reference points, relating to 'newer' subjects. This allows us to see where there are differences between the different subjects, and to identify whether any is particularly

[12] UCAS report for QCA, *Investigation into the use of unit grade information amongst UCAS pilot institutions for 2006 entry and selected schools and colleges*, (unpublished) June 2007.

different to the others. For further information about these analyses and for full results, see Appendix A.

Joint Council for Qualifications Inter-Awarding Body Statistics

This data is drawn from the published Joint Council for Qualifications Inter-Awarding Body Statistics, and is used to examine grade boundaries and achievement over time. For further information about these analyses and for full results, see Appendix B.

Awarding body statistics on resitting behaviour

These statistics were commissioned from Edexcel, OCR and AQA to provide comparative information about resitting behaviour and its impact on student A level grades in summer 2006. These statistics relate only to candidates who were 16 years old by 1 September 2004 and who had a complete set of three AS unit results. See Appendix C.

Grade ranges for GCE mathematics

This data was commissioned from Edexcel to show notional cash-in and unit grade distributions for GCE mathematics for each combination of units for candidates who had achieved AS by summer 2006. These statistics relate only to candidates who were 16 years old by 1 September 2004 and who had a complete set of three AS unit results. See Appendix D.

Analysis of QCA participation in A level mathematics questionnaire

There have now been three questionnaires completed by schools and colleges responding to, in the first year, either a paper-based questionnaire (to a target sample) or an on-line questionnaire that was promoted through a number of different websites and email groups. Each year those responding to the survey were asked to supply contact details (email). They were sent direct email links to surveys in subsequent years to encourage continued involvement.

The evidence has been reviewed by year, in comparison with the previous year, and then across years – both with a small matched sample, and across all responses in each year. Longitudinal data for 2005 to 2007 is reported in Appendix E and the results for 2006 and 2007 appear in Appendix F and G respectively.

The questionnaires were developed to address the main issues of the extent of current participation and dropout of AS and A level mathematics students, as well as to look at the efficacy of various strategies in encouraging retention and participation. The questionnaires contained a number of common questions over time, as well as a number of specific questions each year.

Case study centres

Case study schools were drawn from a Schools Coordinating Unit sample and case study colleges were drawn from a Learning and Skills Council database. Twenty centres were invited and 19 agreed to become case study centres. The centres were all sent a staff questionnaire and copies of a student questionnaire in December/January 2004. Mathematics specialist consultants visited them in February and March 2005, and teaching staff were interviewed by telephone in July 2005. Interview schedules were designed to provide more qualitative information about the centres' reactions to the new specifications, as well as to look at the issues around retention and participation.

The student and staff questionnaires were replicated in December 2005, with a further staff questionnaire sent out in December 2006. There were repeat visits to schools to interview staff and students in March and April 2006. In addition, there was a seminar held for teachers and students in February 2007.

a. Staff questionnaire report – December/January 2006 (full details at Appendix H).
b. Staff questionnaire report – December/January 2007 (full details at Appendix M).
c. Student questionnaire report – December 2006 (full details at Appendix I).
d. Staff interviews report – March/April 2006 (full details at Appendix J).
e. Student interviews report – March/April 2006 (full details at Appendix K).
f. Report on seminar for staff and students – February 2007 (full details at Appendix L).

Participation and achievement

The issue of participation in GCE mathematics is considered at various levels in the project. National results data is used to provide an insight into the overall patterns of participation over time (2001–6), and the large-scale questionnaire and case study centres are used to try to find a sense of centres' experience of participation. All these sources are discussed below and reported in detail in the source appendices.

Matched candidate analysis

The initial analysis looked at the overall national cohort of all young people in England in their 18th year in the reference years 2001–4. Within these there are sub-cohorts: AS only (those within the cohort achieving at AS, but not at A level for any subject) and A level (those achieving one or more full A levels). The A/AS cohort is the sum of these sub-cohorts.

A level cohorts over time

Since 2001, and the introduction of Curriculum 2000, there has been a significant increase in the proportion of the national cohort taking A and AS qualifications, rising from 38 per cent in 2001 to 43.2 per cent in 2006, a slight decline from the 2003/4 high of 44.2 per cent.

The most striking increase is the proportion of students taking AS only which has almost doubled from 3.7 per cent to 7.3 per cent. The AS qualifications prior to 2001 were advanced supplementary, intended to provide additional breadth at the full A level standard. The Curriculum 2000 AS qualifications were designed to be at advanced subsidiary level, the first half of full A level, and so not at the full A level standard. For this reason pre- and post-Curriculum 2000 AS awards will not be compared in this report.

Take-up of mathematics as a proportion of all A levels taken

Analysis then moved to look at the position of mathematics, and five comparative subjects (English, physics, geography, media and psychology) within this context. Table 5 shows how these subjects have fared over time as a proportion of all A levels taken.

Table 5. A levels taken

	2001	**2002**	**2003**	**2004**	**2005**	**2006**
All A levels	549,873	592,350	613,438	615,470	628,116	647,538

Table 6. Distribution by subject (%)

	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Mathematics	9.0	6.8	6.6	6.7	6.5	6.9
Further mathematics	0.9	0.7	0.7	0.7	0.7	0.9
English	12.5	11.5	10.9	10.8	11.2	11.0
Physics	4.7	4.4	4.0	3.7	3.5	3.3
Geography	5.8	5.1	4.9	4.6	4.3	4.2
Media	0.0	2.3	2.5	2.6	2.5	2.7
Psychology	0.4	4.2	4.8	5.3	5.6	6.0

In Table 6, all subjects that we used for the original comparisons dropped their share of the total A levels taken to a greater or lesser extent between 2001 and 2006. Mathematics took the most severe drop of all subjects considered, a total of 2.1 percentage points, compared with 1.5 in English, 1.4 in physics and 1.6 in geography. Mathematics did show, within this figure, an improvement in 2006, in contrast to both physics and geography which have shown continual decline in this time.

A view of the additional comparators, media and psychology, shows a picture of continued increase in share over time, from 0 to 2.7 in media, and a very impressive 0.4 to 6.0 for psychology, a larger share than either physics or geography.

The inclusion of these new subjects illustrates, to some extent, the gains of new subjects at the expense of the old.

Take-up of A level further mathematics as a proportion of A level mathematics

In the same period, for the matched candidate sample, there has been a significant increase in the proportion of A level mathematicians taking A level further mathematics, rising to 12.7 per cent from 9.6 per cent in 2001, the biggest change in this figure was from 10.9 per cent in 2005 to 12.7 per cent in 2006. In the interim report we noted a 1 per cent increase in the proportion of A level mathematicians taking further mathematics and speculated that the decrease in mathematicians had been at the less able end of the spectrum with more able mathematicians who also take further mathematics representing a larger proportion. This was supported by data showing that there had been a slight increase in the average GCSE point score of mathematics A level students over time that did not hold true for further mathematicians. The profile of GCSE point score for mathematicians and further mathematicians at A level has held steady over the last two years.

Take-up of A level mathematics by A level students

Total numbers of A level students are shown in Table 7 broken down by subjects in Table 8.

Table 7. A level students

	2001	2002	2003	2004	2005	2006
A level students	205,930	228,161	237,367	235,107	236,194	238,398

Table 8. Number of students taking A level subjects (%)

	2001	2002	2003	2004	2005	2006
Mathematics	24.0	17.5	17.2	17.7	17.4	18.6
Further mathematics	2.3	1.8	1.8	1.9	1.9	2.4
English	33.3	29.7	28.3	28.4	29.8	29.9
Physics	12.7	11.4	10.4	9.6	9.3	9.0
Geography	15.4	13.2	12.7	12.2	11.5	11.4
Media	0.1	5.9	6.4	6.7	6.7	7.4
Psychology	0.9	10.9	12.5	14.0	14.8	16.2

Table 8, at the level of the individual, shows more strikingly the decline in the proportion of individuals taking mathematics at A level, but also some possible recovery in the first year of the new award. The percentage of students taking mathematics declined from

24.0 per cent in 2001 to a low of 17.4 per cent in 2005, but rose to 18.6 per cent in 2006. This represents a drop of 22.5 per cent overall. The original comparison subjects all experienced a drop, in English the overall drop has been 10.2 per cent. In physics and geography the figures are even more striking than in mathematics, they do not have a 2006 clawback, and show a total drop of 29.1 per cent for physics (a close cognate for mathematics) and of 26 per cent in geography. Further mathematics has shown an overall increase from 2.3 per cent to 2.4 per cent (with a somewhat varied experience in between), a gain of 4.3 per cent.

The new comparator subjects, media and psychology, again show very different patterns to the original subjects – showing continued growth over all the years, from negligible levels in 2001 to 7.4 per cent in media and 16.2 per cent in psychology in 2006.

Take up of AS mathematics by AS level students

Table 9 shows students who achieved one or more AS qualifications, but no full A levels. Over this time, the picture for the comparator subjects has been mixed. Mathematics showed a decline from 15.6 per cent in 2001 to 12.3 per cent in 2005, but has – in 2006 – recovered to 13.7, its highest point since 2001. English has risen from 17.4 in 2001 to 23.5 in 2006. Physics has, on balance, shown an overall decline from 7.9 to 7.6, although there was some increase in 2002, the picture since then has been one of decline. Geography shows an overall increase from 6.4 to 7.4, but the picture since the 2002 high of 8.4 has been one of continued decline. Media and psychology, as in all indicators have continued to increase share, media rising from 7.9 to 12.1 and psychology from 15.5 to 24.7. These very high figures for these subjects, when compared with their A level totals, show their popular use as AS only provision.

Table 9. Percentage proportion of students taking AS only (not achieving A level)

	2001	**2002**	**2003**	**2004**	**2005**	**2006**
Mathematics	15.6	13.2	12.5	12.4	12.3	13.7
English	17.4	24.1	23.2	23.2	23.7	23.5
Physics	7.9	8.4	8.0	7.8	7.4	7.6
Geography	6.4	8.4	8.3	7.7	7.3	7.4
Media	7.9	9.4	9.9	10.8	11.2	12.1
Psychology	15.5	18.8	20.0	22.0	22.8	24.7

Take-up of AS mathematics by A level students

Table 10 shows students who have taken full A levels in one or more subjects, but only an AS in the named subject. This may be exemplified as the ‘fourth AS’, or the subject that students decide not to continue to full award status. It is interesting to see in this table that mathematics started with a considerably larger percentage of AS than other subjects, 3.4 per cent compared with less than 1 per cent in the other subjects. In 2002 mathematics jumped to 8.3 per cent in the wake of the problems with AS results in 2001. It appears that many students were deterred from progressing on to A2 mathematics by their 2001 AS results. However, English has seen the largest increase in this category, gaining from 0.9 per cent to 6.6 per cent from 2001 to 2006. Both physics and geography have seen large increases in the proportions they have in this category, physics from 0.8 per cent to 4 per cent, geography from 0.5 per cent to 3.3 per cent. Further mathematics has increased from 0.9 per cent to 1.2 per cent.

Table 10. Proportions of students taking at least one A level, but only an AS in a comparison subject (%)

	2001	2002	2003	2004	2005	2006
Mathematics AS	3.4	8.3	7.2	6.7	6.0	6.3
Further mathematics AS	0.9	0.8	0.7	0.9	1.0	1.2
English AS	0.9	6.1	6.2	6.2	6.5	6.6
Physics AS	0.8	3.4	3.5	3.6	3.7	4.0
Geography AS	0.5	3.5	3.3	3.1	3.1	3.3
Media AS	–	3.1	3.3	3.8	3.8	3.7
Psychology AS	–	7.7	8.3	9.4	10.0	10.3

Although these gains look encouraging at one level, it is worth looking at them in the context of Table 8 where all the comparator qualifications have shown a decrease in their overall share of A levels taken, except for the new comparators psychology and media, where significant gains have been made. It is likely that those qualifications have seen the increase in take-up – the ‘newer’ qualifications were initially taken as the ‘fourth’ AS, but were carried on to A level at the expense of subjects such as mathematics, physics and geography.

The new subjects show a pattern of net growth from 2002 (when full A levels were available), media has gained from 3.1 to 3.7 per cent, whereas psychology has continued to grow from 7.7 per cent to 10.3 per cent in 2006.

A level as a proportion of AS

Analysis of all students taking A level as a proportion of all those taking AS for each subject (Table 11) shows the two new comparator subjects having far lower ‘conversion rates’ from AS to A2 than the other subjects, with their A levels representing a lower percentage of their total AS students than the other subjects – in the low 50 per cent area – demonstrating their frequent pattern of use as an additional AS subject, often dropped at the end of year 12. Of the more mature subjects physics has the lowest ‘conversion rate’, although mathematics has generally had a lower rate over all the review years, it has shown a fairly constant increase since 2002. English shows the highest rate of conversion at 72.4 per cent.

Table 11. A level as a proportion of AS – all subjects (%)

Year	Mathematics	English	Physics	Geography	Further mathematics	Media	Psychology
2001	82.6	92.4	88.2	92.8	68.4	0.8	6.3
2002	62.1	74.1	69.6	72.4	68.9	55.2	49.8
2003	64.1	72.6	67.3	72.2	70.4	55.2	50.7
2004	66.0	72.5	65.2	72.3	68.4	53.2	50.3
2005	67.5	72.7	67.4	71.8	65.6	52.7	50.4
2006	67.1	72.4	62.0	70.3	65.0	54.5	51.3

Student prior attainment

Looking at students' average GCSE point scores in Tables 12 and 13 shows that physics and mathematics students have the highest average point score of all comparator subjects for A level students. Psychology and media show the lowest average GCSE point scores, with media the lowest of all. In 2006 our comparator subjects all remain relatively stable. There has not been a 'democratisation' of the type of student achieving mathematics.

Table 12. Students taking at least one A level, but only an AS in comparison subjects (average GCSE point score)

	2001	2002	2003	2004	2005	2006
Mathematics AS	5.9	6.2	6.2	6.3	6.2	6.2
English AS	5.6	5.9	5.9	5.9	5.9	6.0
Physics AS	5.8	6.2	6.2	6.3	6.3	6.3
Geography AS	5.5	6.0	6.0	6.0	6.1	6.0
Media AS	5.4	5.5	5.5	5.5	5.5	5.5
Psychology AS	5.8	5.7	5.7	5.8	5.8	5.8
*Further mathematics AS**	*6.9*	*6.9*	*7.0*	*6.9*	*7.0*	*7.0*

Table 13. A level students (average GCSE point score)

	2001	2002	2003	2004	2005	2006
All A level	5.9	5.8	5.9	5.9	5.9	6.0
Mathematics	6.5	6.6	6.7	6.7	6.7	6.7
English	6.0	6.0	6.1	6.0	6.1	6.1
Physics	6.5	6.5	6.6	6.6	6.6	6.7
Geography	6.1	6.1	6.1	6.2	6.2	6.2
Media	5.4	5.5	5.5	5.5	5.5	5.5
Psychology	5.6	5.9	6.0	5.9	6.0	6.0
*Further mathematics**	*7.1*	*7.1*	*7.1*	*7.1*	*7.1*	*7.1*

**Note: further mathematics scores are a subset of mathematics scores, and will not be discussed separately.*

There is an interesting point of reference between the two sets of scores shown – mathematics and physics show both the highest GCSE point scores in each set of information, but also the biggest difference between the two scores, demonstrating a significant spiralling up of the cohort's achievement between the same award (achieved through wastage of the comparatively lower achievers at the end of AS). Mathematics saw a gain of 0.5, and physics of 0.4, otherwise gains are limited to 0.1 or 0.2.

Analysis of examination results – Joint Council for Qualifications Inter-Awarding Body Statistics

This data is drawn from the published Joint Council for Qualifications Inter-Awarding Body Statistics, and so excludes candidates who would have appeared in the provisional results but subsequently declined their grade.

Table 14. A level subject entry over time as a percentage of 1999 entry

Year	Mathematics	English	Geography	Physics	Media	Psychology
1999	100.0	100.0	100.0	100.0	100.0	100.0
2000	96.1	95.5	89.4	94.8	107.5	103.4
2001	96.2	93.2	88.9	95.4	118.7	105.9
2002	76.9	87.8	81.8	91.7	141.9	115.3
2003	79.8	88.0	83.1	88.6	164.6	137.7
2004	82.8	88.6	79.5	82.7	178.5	152.9
2005	83.9	93.5	76.4	81.6	183.4	164.0
2006	91.5	95.6	76.6	81.6	197.1	176.5

Table 14 shows A level subject entry over time, as a percentage of 1999 for A level. We can see a substantial drop in mathematics entry from 2001 to 2002, substantially more than in other subjects and not accounted for by the variation in size of the A level cohort which increased in this time. There has been significant recovery in numbers since 2002, so that the mathematics entry is now 91.5 per cent of its 1999 amount showing a sharp increase in 2006, following on from the increase in 2005 AS entries. English has shown the highest proportion of the 1999 entry at 95.6 per cent, but mathematics is far higher than physics with only 81.6 per cent and geography with 76.6 per cent.

Media and psychology figures have shown large increases consistently, but there were very small entry figures in 1999.

This information, taken together with the increase in the proportion of students taking A level mathematics shown above, indicates a rise in participation levels in mathematics. The 2006 figures for A level are the first full cohort results in respect of the full A level award, and show the largest year-on-year increase over the period.

Table 15. Percentage of entry gaining A–E at AS level

Year	Mathematics	English	Geography	Physics	Media	Psychology
2001	66.6	92.8	86.5	83.0	94.4	83.4
2002	81.7	94.7	91.7	86.6	94.6	83.9
2003	82.7	95.2	91.9	85.6	95.0	82.7
2004	84.6	95.5	91.7	85.8	95.2	84.1
2005	86.4	96.3	92.0	86.6	95.3	84.5
2006	84.3	96.0	90.8	84.2	94.3	81.5

Table 15 shows the percentages of the subject entry achieving at grades A–E in AS. The very low pass rate for mathematics in 2001, compared with the other subjects, relates to the well publicised AS examinations that year where there was a very high rate of failure. The recovery in achievement rates in 2002 is spectacular, and there has been modest improvement since then. Between 2004 and 2006 there were relatively small net changes to percentages gaining A–E grades, the largest change is in psychology with a movement from 84.1 per cent to 81.5 per cent.

Psychology, physics and mathematics show quite significantly lower rates of achievement than English, geography and media, although mathematics has shown the most spectacular increase between 2001 and 2006, rising from 66.6 per cent to 84.3 per cent.

This information is interesting since it is a demonstration of the relatively larger proportion of failure at AS for mathematicians, particularly in 2001.

Table 16. Percentage of entry gaining A–E at A level

Year	Mathematics	English	Geography	Physics	Media	Psychology
1999	89.8	92.7	92.8	89.8	95.0	83.0
2000	90.2	93.2	92.7	89.9	95.0	83.5
2001	90.2	93.9	93.2	89.9	96.0	84.7
2002	95.4	98.4	98.0	94.3	98.2	93.4
2003	95.7	98.6	98.1	94.3	98.3	94.6
2004	96.4	98.6	98.4	94.9	98.5	95.4
2005	96.8	98.8	98.7	95.1	98.8	95.8
2006	97.1	98.8	98.7	94.7	98.8	95.3

There is much more uniformity in these figures, when compared with AS achievement rates. All subjects show an increase in rates over time. Note there was no drop in achievement in 2002 of a similar order to that seen in mathematics at AS in 2001, rather there was a substantial increase in pass rates (from 90.2 per cent to 95.4 per cent).

In 2005/6, pass rates were much the same in most subjects, with mathematics showing a slight increase, and physics a slight decrease. The new comparator subjects show some increase over time, the most dramatic example being psychology. Interestingly, the large increase in psychology pass rates was seen between 2001 and 2002 which corresponded with a hike in average student GCSE point score (from 5.6 to 5.9), possibly illustrating a change in the composition of the cohort.

Comparison of 2006 AS pass rates and 2006 A level pass rates shows highest levels of disparity between mathematics (86.4 per cent at AS and 97.1 per cent at A level) and psychology (84.5 per cent as AS and 95.3 per cent at A level). Physics shows a relatively high level of disparity, but English, geography and media are all much closer. This also contributes evidence to support the hypothesis that mathematics AS ‘weeds out’ a significant number of less able students.

Table 17. Percentage of entry gaining A–C at AS level

Year	Mathematics	English	Geography	Physics	Media	Psychology
2001	44.6	62.7	60.7	58.7	68.0	50.7
2002	58.1	63.6	64.6	61.3	63.3	52.4
2003	59.7	62.0	64.0	59.1	64.4	50.9
2004	61.4	63.2	64.5	59.4	66.7	52.0
2005	64.6	65.4	64.6	60.0	66.3	52.8
2006	62.4	65.1	60.4	57.6	64.5	48.6

Table 17 shows the impact of the 2001 problems with AS mathematics on the percentage A–C grades, with its figures showing substantially poorer performance than other subjects, and than other years for mathematics. Since 2002 mathematics has generally shown an increase, as has English, but all other subjects have shown a net decline in this time.

Table 18. Percentage of entry gaining A–C at A level

Year	Mathematics	English	Geography	Physics	Media	Psychology
1999	65.3	58.5	62.8	63.6	58.0	51.0
2000	66.1	59.6	64.1	63.8	57.0	51.0
2001	65.5	61.2	65.1	63.7	62.7	54.0
2002	75.8	70.7	71.9	67.0	68.4	59.7
2003	76.8	72.2	74.1	67.4	68.5	63.6
2004	78.2	72.0	75.5	69.2	71.9	65.5
2005	79.9	73.2	76.2	69.3	73.7	65.2
2006	81.0	74.6	77.0	68.9	74.2	65.2

For A level, 2002 is the first year of awarding Curriculum 2000 A levels, and there is a very large increase in high grade achievement in mathematics and English in particular in this year, shown in Table 18, with mathematics rising from 65.5 per cent to 75.8 per cent and English from 61.2 per cent to 70.7 per cent. The rates of A–C have continued to improve in all subjects since this time (although physics showed a slight decline in 2006).

The rates of achievement at A–C at A level are much higher than equivalent grade achievement at AS, particularly in mathematics, geography and psychology.

Table 19. Percentage of entry gaining A at AS level

Year	Mathematics	English	Geography	Physics	Media	Psychology
2001	20.9	17.5	20.2	24.6	13.8	13.6
2002	29.4	18.0	23.4	26.2	12.1	15.7
2003	29.7	16.9	23.3	25.3	13.3	15.1
2004	31.3	16.9	23.4	25.0	14.7	15.1
2005	34.4	18.0	24.0	25.2	14.4	14.9
2006	32.0	17.4	22.6	22.9	13.8	13.1

It is interesting here that, even for the first Curriculum 2000 AS in mathematics in 2001, mathematics students still gained proportionately more A grades than those in either English or geography. The difference between mathematics and English is now extremely large with 32 per cent in mathematics and only 17.4 per cent in English gaining A grades. The figures are lower for both media and psychology (13.8 and 13.1 per cent respectively), but it should be noted that the prior achievement levels for both these subjects are lower than the original comparator awards.

Table 20. Percentage of entry gaining A at A level

Year	Mathematics	English	Geography	Physics	Media	Psychology
1999	29.2	15.4	16.7	24.6	9.3	12.1
2000	29.8	16.0	18.1	25.1	9.7	12.0
2001	30.2	17.0	19.5	25.3	11.4	13.2
2002	40.3	19.3	21.0	27.8	11.7	16.2
2003	40.6	20.6	23.6	28.2	12.4	17.7
2004	41.9	21.3	24.7	29.6	13.5	18.7
2005	44.1	21.3	25.0	29.7	13.0	18.5
2006	45.3	21.9	25.6	29.4	13.3	17.8

The difference between mathematics and other subjects is extremely marked in this table, with over 45 per cent achieving A grades in 2006, compared with the high of 29.4 per cent in physics, 25.6 per cent in geography, and 21.9 per cent in English. The difference between Tables 18 and 20 is striking since the subjects are much more similar at the A–C range.

The series of Tables from 15 to 20 are very interesting with respect to the two new comparator subjects, media and psychology, when considered next to the original subjects. Although there are fairly comparable overall rates of achievement from A–E, the rates of achievement at the higher levels of A–C and A grade for both AS and A level are markedly lower.

The statistics on average GCSE point score show that these students have the lowest scores of all the subjects looked at, with media significantly lower than the rest. Media does show the lowest achievement rates at the highest grades. In fact, a cross-reference of the average GCSE point score to this table on proportions of A grades achieved demonstrates an exact match of position between level of GCSE point score and proportion achieving A grade – mathematics has the highest point score, and the highest proportion of A grades, physics the second, and so on.

The comparisons about AS and A level achievement hold across all grade achievement – with mathematics consistently showing the largest differences between AS and A grades in 2005 AS and 2006 A level.

Male/female participation

The proportions of males and females taking A level and AS were compared over time – 1999 to 2004. In all cases for the comparison subjects, the proportions have remained steady over time. There are big differences between subjects in terms of male/female balance, with psychology replacing English as the subject with the greatest female bias (69.3 per cent in English in 2006 compared with 74.4 per cent in psychology) and physics the most male (77.7 per cent in 2004 and 78.25 per cent in 2006), males accounted for 62.2 per cent of the cohort in mathematics A level in 2004 and 62.1 per cent in 2006. In both physics and mathematics there is a persistently, but slightly, higher proportion of females doing AS than A level indicating proportionately higher dropout by females after AS.

Edexcel, OCR and AQA – 2006 examination sitting patterns

Following on from the OCR data reviewed last year, a wider sample of information about examination sitting patterns was commissioned from awarding bodies this year for another purpose, but bears scrutiny here. The comparator group is slightly different from the large-scale results data and comprises: French, English literature, geography, psychology, physics, media studies and mathematics.

Last year we were not able to look in detail at the average benefit to students in retaking mathematics units – the average increase in grade. We hypothesised that the average benefit was likely to be greater in mathematics than in other subjects because of its nature. This year we are able to review a range of subjects, as well as the average benefits of resitting.

In preparing the data, the degree of flexibility in the mathematics A level led the awarding body to provide six sets of figures for each of the possible A levels, compared with a single consolidated set for the other subjects. This is useful since it means that we can also look at relative performance across the different 'qualifications'.

The full analyses are shown in Appendix C. However, as a summary the following is worthy of note. The rate of resitting varies across the combinations of A level mathematics. However, in all cases there are always at least 25 per cent of candidates resitting four units (and sometimes a similar proportion resitting a further unit). This is not typical in other subjects except physics, and it is noticeable that those mathematics qualifications containing a higher proportion of AS units show the higher rate of resitting across more units.

In addition, although still relatively infrequent, the mathematics figures show increased rates of resitting on two or more occasions than other subjects. French shows the closest parallel – doubtless because of the maturation benefit of this award, which is seen also to some extent in physics. In all subjects except mathematics there is almost no reported multiple resitting in the A2 component of the qualifications.

In terms of the benefits of resitting, Table 21 shows the impact of resitting behaviour in respect of AS units on final A level grades at grade A. In this model the data shows the notional grade that a student would have achieved had the A level been awarded on the basis of their AS grades at the end of the first year of study, compared with the A level grade achieved by the end of the programme, which takes into account any resitting in the second year.

Table 21. Returns to resitting

Awarding body	Subject	Achieving grade A (%) in a notional A level result (using AS result at end of year 1)	Achieving grade A (%) in A level result (using AS result at end of year 2)	Change
AQA	Psychology	17.5	19.8	+2.3
AQA	English literature	21.5	24.0	+2.5
AQA	Physics	26.6	31.1	+4.5
Edexcel	English literature	25.4	30.4	+5.0
Edexcel	French	26.2	33.4	+7.2
Edexcel	Mathematics M1, S1*	39.3	47.1	+7.8

As can be seen from this table, mathematics (this used the M1 and S1 version – the largest entry) is the biggest beneficiary of the resitting strategy providing an increase in the proportion of A grades achieved of 7.8 percentage points. As may be expected, French is also a notable beneficiary of this behaviour, like mathematics, it is a subject where maturation in the subject leads to improved performance in earlier units.

Large-scale questionnaire

Since the initial large-scale questionnaire was completed in February 2005 there have been two more survey sweeps, in February 2006 and in February 2007. Some of the core questions were retained year on year, and provide some insight into the question of participation. Final frequencies of analysed data were similar in each year, 190 in 2005, 188 in 2006 and 191 in 2007. A small sample of centres was matched across years, but this sample is only 33 centres, so figures relating to this sample should be treated with caution. This section will review data across the years, where possible or relevant.

In the strictly matched sample, the mean number of students at the beginning of the year for AS students was 43.3 in the 2005 survey and 55.5 in the 2007 survey. Comparison of the year-on-year survey responses also shows an increase, from a mean of 43.3 in 2005 to 47.6 in the 2007 survey. As this sample is not matched, it is not possible to know how much variation may be accounted for by sample differences.

Centres were asked in 2006 why they thought there had been changes in the numbers of students recruited. The factors that were cited most frequently in centres reporting increased student numbers were resources and logistics, followed by attitudes. Those cited most frequently in centres reporting decreased student numbers related to attitudes, then issues around difficulty. There were almost twice as many centres reporting increased student numbers (80) as decreased (45).

The same question in relation to A2 numbers shows for the matched sample an increase in mean numbers of students from 26.2 in 2005 to 34.8 in the 2007 survey, although there is some centre type variation. For the year-on-year survey responses, the 2005 survey centres had a mean A2 group of 26.2 compared with 30.1 in 2007. The same caveats apply.

Surveys in 2006 and 2007 also asked about A level in one year students and saw the total in all centres rise from 11.9 to 17.3 in matched centres.

In terms of early dropout (between September and February) in each year there was a dropping rate of nine per cent in 2005 compared with eight per cent in 2007, although the rate was seven per cent in 2006. At A2 the analysis showed a dropout in a similar period of 4.8 per cent in 2005 compared with 2.2 per cent in 2007 – again there was a lower dropout rate in 2006 of 1.8 per cent. For A level in one year students, the rate dropped from 6.8 per cent in 2006 to 3.3 per cent in 2007.

Centres were asked to provide details of their AS and A2 mathematics' cohort sizes, and these figures were analysed to look at their relative sizes. In 2005, for all centres the total of A2 students was around 63 per cent of the total of AS students, in 2006 this was around 59 per cent, in 2007 this figure was around 62 per cent, so there has been no clear trend here. However, the information above taken together indicates a growth in group sizes at both AS and A2 in this sample, which reflects the national increase in the proportion of students who are studying mathematics GCE.

Case study centres

In the interim report, the data, like the early survey, indicated that levels of recruitment between 2000 and 2004 had been pretty much the same.

In 2005/6 some of the centres reported that larger or much larger numbers of students were now studying AS mathematics or continuing to A2. Some indicated that students with a wider range of abilities were choosing AS mathematics and continuing to A2. One said that this included more GCSE intermediate tier students, who seemed to be coping. This change is not reflected in the matched candidate data that looks at prior GCSE grades, which shows a consistency in the prior achievement of students. However, if this is something that has happened recently, it may feed through into later results. It should be noted, of course, that GCSE mathematics is moving to a two-tier model, so there will no longer be two routes to grade B. This may be helpful in that all students with a grade B will have had to cover the same areas of study.

Longitudinal comparison of the 2005 and 2006 case study centres questionnaire data found that the size of the AS and A2 mathematics cohorts had increased and outstripped the increase in the Curriculum 2000 cohort more generally. This reflects the similar increases reported in the other data sources described above.

A further such longitudinal comparison found that A level mathematics students made up one per cent more of the Curriculum 2000 cohort in 2005/6 than in 2004/5 (28 per cent to 29 per cent at AS and 21 to 22 per cent at A2).

No such comparison is possible with the 2007 data because of the high degree of 'churn' in the responding sample. A crude comparison of the 2007 data with the longitudinal data for the previous two years suggests that the mathematics cohort makes up a similar but slightly lower proportion of the Curriculum 2000 cohort (26 per cent at AS and 18 per cent at A2).

However, teachers at the seminar generally said that more students had started A level mathematics in September 2006 than in September 2005. One teacher reported that recruitment had recovered towards levels last seen before the implementation of Curriculum 2000.

In 2006/7, some of the teachers suggested that informal feedback from students taking the A level to students making their A level subject choices, for example between siblings, had begun to make a difference and was to some extent a factor in the improvement.

This contrasts with 2005/6, when several staff said that news was only just beginning to spread that the new specification made A/AS level mathematics more accessible, although they expected that this would eventually have an effect.

Eight centres said that they had the capacity to take more mathematics students, but three could not increase their intake or only with difficulty.

Dropout and non-continuation from AS to A level

In the absence of reliable national data across all centre types on dropout during courses, this project has tried to provide a feeling for the level of dropout during courses, as well as unintended drop-down between AS and A2, both in the case study centre data and the large-scale questionnaire. It is hoped that this will shed some light on the magnitude of this hitherto ‘invisible’ attrition.

Respondents to the large-scale survey in each year have supplied numbers of students starting AS mathematics at the beginning of the academic year, and the total number dropping the subject between then and February (when the questionnaire was completed). The data show a dropping rate of 9 per cent in 2005 compared with 8 per cent in 2007, although the rate was 7 per cent in 2006. At A2 the analysis showed a dropout in a similar period of 4.8 per cent in 2005 compared with 2.2 per cent in 2007 – again there was a lower dropout rate in 2006 of 1.8 per cent. For A level in one year students the rate dropped from 6.8 per cent in 2006 to 3.3 per cent in 2007. Dropout rates at A2 are much lower than at AS for all three years. The picture here does not describe a clear trend, and it cannot be concluded that within year attrition has changed in the period since the new specification began.

The data were also examined in terms of the spread of dropout. This showed 70 per cent of the 33 centres matched across the years reporting no dropout at all in 2006/7, 78 per cent in 2005/6 and 64.5 per cent in 2004/5, again no clear trend. In all three years, over 90 per cent of centres reported dropout of 25 per cent or less.

In the case study centres, the experiences of individual centres were somewhat varied but generally speaking only a few students dropped A level mathematics between September and February in 2004/5, 2005/6 and 2006/7 in each centre. Indeed, most reported that one student or none had dropped the subject at AS or at A2 in either year.

A longitudinal comparison of 2004/5 and 2005/6 case study data showed a slight worsening in retention or, if a large college with much lower than average retention is excluded, a slight improvement. The 2006/7 data did not support a longitudinal comparison.

In February/March 2006, four centres reported a lower dropout rate in year 12 during 2005/6 than previously and three said that progression into year 13 mathematics had improved in September 2005.

Data for 2004/5 and 2005/6 suggest high completion rates for AS mathematics and particularly A2 mathematics amongst case study school students. In the first of these two years it was 93 per cent and 98 per cent respectively. For a different but similarly small sample of centres the rate was lower in the following year at 82 per cent and 96 per cent.

Retention AS to A2

Respondents to the large-scale questionnaire were asked a series of questions about their previous cohort of AS students and the numbers continuing to A2. The data was then analysed to represent percentages of students completing AS who did not progress to A2.

Comparing 2007 with 2006 and 2005 there is a slightly lower percentage of AS completing students who did not progress to A2 in 2007 – a higher retention rate. In the strictly matched sample, this showed that in 2005 the retention rate for all centres was around 69 per cent, in 2006 and 2007 the rate was 70 per cent. Looking at the year-on-year data in respect of this question (all responses) comparing 2007 with 2006 and 2005 also shows a lower percentage of AS completing students who did not progress to A2 in 2007 – a higher retention rate. In 2005 and 2006 the retention rate for all centres was around 67 per cent, in 2007 the rate was 74 per cent.

The respondents were asked a further question: how many of the completing AS students did they think intended originally to complete the full A level? Analysis was carried out using only centres who answered all three questions to calculate the difference between actual and predicted attrition between AS and A2.

For the strictly matched sample of centres the data indicates a reduction in the proportion intending to progress who did not, from 9.7 per cent in 2005 to 1.6 per cent in 2007. The figure in 2006 was 7.1 per cent. Analysis by centre type indicated that by 2007 some students were choosing to progress who teachers did not think had intended to at first, giving negative numbers in the results of this calculation. The trend in this period was linear.

The unmatched figures over the same period also indicate a reduction in the proportion intending to progress (from 80.4 per cent in 2006 to 75.4 per cent in 2007, but also an increase in the proportion actually progressing (to 73.6 per cent from 68.1 per cent) this shows a very narrow difference in 2007 of 1.8 per cent of those AS completers not carrying on with mathematics who teachers thought intended to, compared with 8.9 per cent in 2005. The rate in 2006 was 12.2 per cent so there is not a simple downward trend in this group.

In the case study group, by January 2006, 14 per cent of the AS mathematics students still on the course said that they planned to drop the subject at the end of AS. This was a higher proportion than for any of the other subjects and was followed by physics at 13 per cent and modern foreign languages at 11 per cent. This may owe something to the level of difficulty experienced by the students (the three subjects were most frequently cited as the hardest subjects for the students).

Other than mathematics, the students were most likely to drop PE, modern foreign languages, psychology, critical thinking and general studies at the end of AS. They were least likely to drop physics, further mathematics, biology, chemistry and business studies. It seems that these A level mathematics students were tending to focus in on a coherent core of mutually relevant and closely-related subjects.

AS students with GCSE mathematics at grade A* were the least likely to be planning to drop mathematics at the end of AS. This pattern was reversed for physics and modern foreign languages. No gender effect was observable for mathematics here.

Several teachers commented on this issue of AS students changing their minds about A2 mathematics. They generally attributed this to students dropping their lowest graded AS subject, which is often mathematics, and this seems linked to comments elsewhere that it is a relatively difficult qualification. Mathematics continues to be a regular casualty of the reduction from four AS subjects in year 12 to three A2 subjects in year 13.

Reasons for dropout and non-retention

The reasons for student dropout and non-retention were examined in several ways by the study. Teaching staff were asked for their views in both the large-scale questionnaire and in case study centre visits and telephone interviews, and students who dropped out or decided not to continue to A2 were interviewed during centre visits.

Large-scale questionnaire respondents were provided with a list of six reasons as well as an option of ‘other’ for why students dropped GCE mathematics. They were then asked to rank order the three main reasons for dropout in their centres.

For AS students, there was a change from 2005 when the question was asked in 2006, the most frequently cited first response was that students’ knowledge was not at an appropriate level, accounting for 32 per cent, and this was followed by ‘mathematics is harder than other subjects’ accounting for 28 per cent. Together these responses accounted for 60 per cent of all responses. This compares with 2005 when these two top answers accounted for 75 per cent of responses.

For the second main reason, the top two responses from the previous question were reversed – as in 2005, and, again as in 2005, these accounted for 61 per cent of all responses.

For A2 an option 'not applicable – including no dropout' accounted for 67 per cent of responses, the proportion responding to this question was larger than last year, but the large majority appeared to indicate that dropout was not a problem for them. The picture was the same in relation to A level in one year students.

Centres were asked about the reasons why the proportion of students dropping GCE mathematics had changed – 31 per cent referred to prior attainment as a reason, and 28 per cent to the apparent difficulty of the course.

Students from case study centres who had dropped out from their GCE mathematics courses were interviewed about their reasons for not continuing. Around half the students interviewed said that they dropped AS mathematics without completing the AS course. Some stopped very early on. Others carried on until the second term. A few dropped it after taking an examination.

Students in one centre described teachers not letting them drop the course when they first asked. About a third of the students said that they dropped AS mathematics after receiving their AS grade. Mostly they made the decision because of their grade. One student said he had a good grade but still decided to drop it (because he preferred other subjects).

The most common reason for giving up was that they were finding the work too difficult. Some also said the pace of work was too fast or the workload too heavy. Eight out of the 30 students said that they were worried that they were giving too much time to mathematics and this was affecting their other subjects. A few students said that they dropped it because it had little relation to what they wanted to do in future.

Non-completers from most centres were positive about the support available to them while they had been on the AS course but more than half of non-completing students said that different teaching methods could have helped them to continue. Suggestions for these teaching methods included better explanations from teachers, smaller groups and a slower pace of work for less able students.

AS students were asked about their intentions to continue to A2. Out of 93 AS students interviewed, 70 said they were intending to continue to A2, although often they said that this would depend on their AS grade.

Student choice of mathematics

Why students do choose mathematics

The case study centres were a rich source of information about why students chose to study mathematics in our interim study, and we have built upon this in our final report.

Gender

In our interim report, our analysis of the case study centres' student questionnaire led us to generate our 'comfort/utility hypothesis'. Although the evidence suggested that both boys' and girls' choice of A level mathematics were motivated by these factors – of comfort with their ability to cope with the subject, and of the utility of the qualification to their later career and education plans – boys appeared to be more motivated by the usefulness of A level mathematics for university and subsequent careers. Girls, on the other hand, seemed more motivated by previous enjoyment and their perceptions of success.

There was no repeat question in the student questionnaires about the reason for study, but more discussion in the interviews, particularly around the hypothesis formed during the interim study that there may be a tendency for girls to rate being comfortable with their ability to cope as very important, compared with a tendency for boys to stress the usefulness of the qualification. Evidence drawn from these interviews has seemed to support and add nuance to this hypothesis. For boys, university/career plans were by far the most frequently occurring reason cited. For girls, the top three reasons occurred with similar frequencies. They were, in order of frequency:

- previous success
- university and career plans
- enjoyment of the subject.

In 2006 all AS and A2 students' main reason for studying mathematics was because it would be useful to them for university entrance or for their career. Enjoyment and ability were also frequently occurring reasons.

A range of reasons for studying mathematics emerged from the data. The majority of students gave more than one reason. The most commonly occurring reasons, in order of frequency of occurrence, were as follows in Table 22.

Table 22. The frequency of responses by gender (1 is most frequent)

Boys		Girls	
1.	University/career plans	1.	Previous success
2.	Previous success	2.	University/career plans
3.	General benefits	3.	Enjoyment
4.	Enjoyment	4.	Complementing other subjects
5.	Complementing other subjects	5.	General benefits
6.	Advice	6.	Advice

University and career plans were by far the strongest motivator given by boys for choosing mathematics, with the second most popular reason being given far less frequently. In the case of girls, there was much less variation in the frequency of occurrence of the first three reasons.

Boys were significantly more likely than girls to say that they chose mathematics because of their university or career plans. Boys were very slightly more likely to give a reason that mathematics was more generally beneficial to have. However, girls and boys generally expressed this differently. Boys talked about mathematics being a ‘good’ subject to have and mentioned its being impressive on a CV. Girls were more likely to say the subject was ‘useful’.

Girls were significantly more likely than boys to say they had based their choice on previous success. They were twice as likely as boys to say that they chose mathematics because of their enjoyment of the subject. Girls were also more likely than boys to give the reason that mathematics complemented their other subjects.

Only a small number of students said that they chose mathematics because they were advised to do it and these were mainly boys.

The case study centre teaching staff were also asked how far they agreed with the theory that boys are motivated more by the usefulness of mathematics and girls by feelings of security. However, in their response there was a split between those who tended to agree with the hypothesis and those who tended to disagree, several – in fact – objected to the stereotypical nature of the question. Several teachers raised the absence of coursework from A level mathematics as a reason why girls may not be drawn to it.

Other motivating factors

The most common reason non-completing students gave for choosing AS mathematics was that they had enjoyed GCSE or done well at it.

Some AS, A2 and non-completing students described mathematics' high status as an A level subject.

Many students said that mathematics would be useful to them for university entrance or for their careers, and the most frequently occurring response from AS students was that they had not decided on a university course but believed that mathematics would be a good subject to have on their UCAS form.

Students named a wide variety of university courses and careers for which they thought mathematics would be necessary or relevant. Most commonly mentioned were mathematics courses or teaching, medicine, engineering and finance-based courses or careers in finance.

Students were finding that their mathematics work helped them with some of their other A level subjects, especially science and business-based courses.

Another common reason given for doing mathematics was that they were good at it, or that they had got a good grade at GCSE. A smaller number of students said it was because they enjoyed the subject. Amongst those students studying further mathematics, the students' enjoyment of the subject was the most frequently stated reason, followed by future plans, and being good at mathematics.

The most common reasons the non-completing students gave for taking up AS mathematics were that they enjoyed GCSE mathematics or that they got a good GCSE grade.

Why students don't choose mathematics

This was an area explored in the interim report in detail and there was no further work carried out with these students in the final year of the study, in favour of new areas of enquiry. The information discussed here therefore stems from the interim report only.

Students who had achieved well as GCSE in mathematics (at least a grade B) were asked why they had decided not to pursue their study of mathematics. Many students said they perceived it to be a difficult subject 'mathematics is notoriously difficult' and therefore it would be difficult to get a high grade. Many students felt that they would need to have more confidence in their mathematical abilities in order to study the subject at a higher level. These students were put off by reports of the level of difficulty experienced by previous students who had struggled despite getting good GCSE results and had told them that mathematics is the hardest subject. For others, seeing the number of low grades (D and E) in the schools' published results put them off the subject.

A small number of students had been discouraged from studying mathematics by their teachers, with the teachers pointing out that it is a big jump from GCSE. One student said that the college does not promote mathematics and it is seen as a specialist area to support subjects like physics. A small but significant number said that they might have studied mathematics if their teachers had given them more encouragement.

The perception of mathematics being a demanding subject meant that many students decided not to study at AS because they thought that it would take up too much of their time and many of these students felt that their strengths did not lie in the subject area. A significant number of students mentioned that they had taken intermediate GCSE and did not think that this would have given them enough of a foundation to study at AS.

A small number of students said that they found mathematics to be a dull subject and they couldn't see the use of mathematics in their future life, for their course or career plans, instead other subjects were deemed to hold more importance to them. One student chose physics over mathematics because it is a more practical subject and experiments emphasise what is being learnt. Some students would have been more interested in taking the subject if there were different levels that one could study at, similar to the GCSE structure, or if you could choose to focus on a few areas of interest in detail. One student viewed mathematics to have no structure, unlike history or English. Other students thought that a lot of the content appears to be 'useless'. Interestingly, many would have studied it if it was a university entrance requirement, or needed for a future career. One group said that A level mathematics impresses people and that if this image had been pushed more then they would have considered studying it.

Mathematics is viewed by a number of students as needing to be more fun, to have more class interaction and more use of the computer. There is a feeling that mathematics needs to be made more practical, for example through the use of games and puzzles. One group said that there were too many interesting options available to take as a fourth AS which made them discount taking mathematics as their fourth option and one or two students would have considered mathematics as a fifth option had their school/college allowed it. Many students mentioned that they would need financial incentives to study mathematics.

One group said that if the school had given them encouragement to take the subject such as an induction lesson then they might have changed their minds. Their perceptions of the subject as being difficult put them off. A significant number would have liked to have had more detail about the course content at AS level when given information about studying A level subjects.

The large-scale questionnaire ‘Further comments’ section yielded a number of comments about why students may not continue with mathematics after GCSE. GCSE mathematics was thought by some respondents to be demoralising to students who completed the course without a good grasp of the subject, and the low grade-boundaries were thought to perpetuate this. It was suggested by a number of respondents that the questions should be made easier and the grade boundaries raised to make GCSE mathematics a more positive experience for students.

There were also some strongly argued comments suggesting the reduction or even abandonment of the coursework requirement at GCSE, particularly the data handling unit. This was said to put students off progressing to AS level mathematics, one respondent referred to the coursework as a ‘millstone’.[13]

Recruitment

This was an area that was explored in greater depth following initial findings in the interim study. The interim report identified that there appeared to be a strategy of recruitment that was focused at a quite narrow range of highly able mathematics students, and that this was sometimes more restrictive than the centre policy on entry.

In interviews, staff reported in 2006 that their centres generally required a B and most of these centres accepted B on the intermediate tier. They were generally using the same criteria as last year, and a few had increased their requirements from B to A, C to B and higher tier C but not intermediate tier B. Teachers present at the seminar confirmed this general requirement of a grade B on the intermediate or higher tier. However, at the teacher seminar it was felt that in practice, centres preferred students to have at least a B on the higher tier and one teacher felt that students should really have an A or an A* if they wanted to take A level mathematics.

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[13] This evidence was gathered prior to the recent changes removing coursework from GCSEs in mathematics.

In one case, students at the threshold are pointed towards other mathematical A levels such as statistics. Three centres mentioned giving special encouragement to the top set to carry on with mathematics.

This tendency to recruit at the top of the entry requirement was reflected in a review of student questionnaire evidence that showed that the great majority of the students had gained A* or A at A level with a trend towards increasing levels of prior achievement (73 per cent had A* or A in 2004/5 rising to 78 per cent in 2005/6) and away from grade B students (from 24 per cent to 19 per cent) while grade C grades were stable (on 3 per cent).

The longitudinal studies in 2006 and 2007 both asked questions about centre policy on entry requirements, as well as teachers' own targeting for recruitment. The question in 2006 did not include A* or a question about grade C, but the grade A or higher category subsumes A* and the 'other' comments picked up the proportion requiring grade C (9.8 per cent in 2006). Comparing the years, the figures indicate an increase in demand for all centres, with 54.5 per cent requiring at least a B at higher tier in 2007 compared with 46.2 per cent requiring this level in 2006. Selective centres had this level of requirement in 78 per cent of centres in 2007 (compared with 74 per cent in 2006) and non-selective in 45 per cent of centres in 2007 compared with 31 per cent in 2006.

Two-thirds of centres reported in 2007 that they occasionally made exceptions to this requirement, 32 per cent said they never did and only 2 per cent said that they did so frequently.

The next series of questions asked about which groups of GCSE students were generally targeted for recruitment. In 2007 the data here showed 78 per cent of centres targeting higher tier only students, and only 16 per cent targeting higher and intermediate students, this was an increase from 75 per cent targeting higher tier only in 2006.

These data reinforce those found in the qualitative information and indicate a tendency to 'recruit up'. There is a clear difference between the criteria and the group of students who are targeted, and in both cases the tendency over the last two years has been an escalation in the level of GCSE achievement.

Students were asked about how they had chosen mathematics. Most A2 students said that taking mathematics was their own choice and they did not need to have it sold to them. Some of these said they had not heard anything about mathematics before making their choice but for most, teachers or, to a lesser extent, family members had encouraged them.

About a third of AS students said that they did not feel anyone had influenced their choice to do mathematics. Some of these said they had been told they had the ability to do AS. Almost the same number of students said that their teachers had actively encouraged them. Encouragement varied in strength from teachers telling some students they ‘had to’ do mathematics – one saying he would be angry if she didn’t – to letting students know they were capable of it. The latter was the most common approach. Students from a few centres said it was expected that students with good grades would do the AS.

For further mathematics students, similar numbers said that they were encouraged to do further mathematics as said they chose to do it without specific encouragement. For those who had been encouraged, this came mainly from teachers and sometimes took the form of a teacher telling them they would be doing the course. Others had strong encouragement, described in terms such as ‘persuaded’ or ‘advised’ to do it. Several students had heard nothing or very little about further mathematics beforehand. Some just read about it in a prospectus or heard about it at open day. On the other hand, three students in one group said that they had specifically sought out a college that did offer further mathematics.

Reports of positive prior experiences of family members and other students doing further mathematics had encouraged some of the students. Very few students reported being warned that it was difficult.

Non-completing students said that teachers, families and friends had made comments about mathematics. While students had generally heard that mathematics was difficult, an equal number said that they had been encouraged by messages that mathematics was a good subject to do in terms of their future prospects and earning potential.

About a third of students said that they had been encouraged to do mathematics by their teachers. A few other students said that positive comments made by teachers about mathematics at open evenings had encouraged them to choose it. A few said that teachers had warned them about the difficulty of mathematics. One said she had been discouraged because she had done intermediate tier GCSE.

Comparison with other subjects – how difficult is mathematics?

Case study students were asked in their questionnaire in 2006 to think about the relative difficulty of the subjects that they were studying, ranking them in order of the easiest and again in order of the most difficult. The results are interesting – 16 per cent of mathematics students said that mathematics was their easiest subject, which compares with 62 per cent of students studying general studies who found that their easiest subject. Subjects rated as 'easiest' less frequently than mathematics include chemistry and computing.

When considering the subjects ranked as hardest by students mathematics comes near the top of the table with 33 per cent, superseded only by modern foreign languages and further mathematics.

In interviews, students were also asked about the difficulty of mathematics and for comparisons with other subjects.

Almost all the A2 students said that they thought the mathematics course was challenging. However, students did not think that the course was too challenging. Where they made comments, often they described the challenge in a positive way. Around half of A2 students commented on the relative difficulty of other A level subjects compared to mathematics. More than a quarter of those commenting said that mathematics was their hardest subject.

When AS students were asked to consider the same question nearly half of all those making a response said it was their most difficult subject, while just over a third said it was their easiest. Around a fifth made comparisons to individual subjects.

Only one AS student said that AS mathematics was insufficiently challenging. All others making comment said it was challenging and they did not think it needed to be any more challenging. While some gave specific topics as the most challenging aspect, others spoke about the difficulty of fully understanding the concepts they were introduced to and learning how to use them. The workload and pace were also seen as presenting a challenge for a few students.

Mathematics was often seen as different from other subjects, students referred to it as being more predictable or 'straightforward'. Some said they preferred this to essay writing.

In direct contradiction to the above, other students said its difficulty lay in the fact that there was a ‘right or wrong’ answer. Some students said they found that the relatively less clear-cut nature of other subjects made them easier.

Non-completing students in the majority of centres specifically said that they found mathematics harder than their other subjects. The main reason they gave was the workload. Students chiefly said that mathematics required a lot of homework and revision in order to learn the content. They also said that they felt it went at a faster pace than other subjects and that it was easy to get left behind, particularly if they missed a lesson. They felt that there was no time to learn things properly and said that they forgot one thing when they moved on to something else.

Clever core – who is mathematics for?

This hypothesis was generated through the interpretation of national data for A level mathematics results over time.

With few exceptions, interviewees believed that mathematics should be available to students within a range of ability similar to that for other A Level subjects. The clever core should be encouraged to do further mathematics as well and given additional stretch as described in the next sub-section. However, smaller schools could not always support further mathematics and extra funding was needed.

Several centres reported increasing enrolments for AS level mathematics, with a wider learner profile and an increasing belief amongst students that it was not only the clever core who could succeed. Several divided their post-16 mathematics students by ability and almost all made extra provision for the more able. They noted, however, that the inclusion of too many weak students tended to depress standards.

At the seminar, a couple of teachers responded on this point by saying that although this was true in previous years, there are now students with a wider range of ability taking A level mathematics. However, these and other teachers felt that ‘we need to encourage more people to have a go’ at A level mathematics and a few suggested that the only way to achieve this might be for them to study a less demanding form of A level mathematics.

In contrast to the clever core issue outlined above, a teacher made this call for action to recruit what some of the teachers reported to be a large group missing from the subject:

> We must put a stop to bright students who don’t do A level mathematics, but who could. Maybe this has always happened, but they voted with their brains, as it’s easier to get good grades in other subjects.

The comments from the teachers therefore suggest that students act strategically in choosing their A levels and that teachers understand and accept this basis for subject choices. This was tempered by some other comments suggesting that some students choose mathematics according to enjoyment or usefulness.

Teachers were also asked whether they agreed with the hypothesis that some students are ‘mathematically extremely able’, in response a couple of teachers said that their students’ levels of ability tend to be polarised. The effect is that those students tend either to gain A/B grades or D/E but not C grades.

When asked whether a student who was not naturally gifted could become an exceptional mathematician, most said that such a student could do as well, or almost as well, through hard work as a gifted student who did not work. A minority thought that the slogger could achieve well but not get the highest grades and/or not achieve at further mathematics. The slogger would never have the flair of the really able.

Experience of mathematics GCSE and transition to A level

All groups of students were asked about their experience of GCSE, and for those continuing to A level, how they had found the transition between the two awards.

Many students spoke of a ‘big jump’ from GCSE mathematics to AS mathematics in both the first and second years of the evaluation.

When asked to rate the move from GCSE to AS mathematics on a scale ranging from very easy, easy, OK, difficult to very difficult, the most frequent response was OK (46 per cent), followed by difficult (30 per cent).

Teachers, however, were able to make comparisons between the old and new A level, and reported that the transition is smoother. C1 was widely seen as a ‘transition unit’ providing an overlap with GCSE. The repetition this provides was usually seen as valuable and more likely to increase retention but a few thought it excessive or that C1 was too easy.

Calculus, graph work and trigonometry were most frequently mentioned suggestions for inclusion in GCSE to help with the transition to A level, although each was raised by a small proportion of students.

There were some concerns that GCSE might not be providing sufficient preparation for the A level, with year 12 sometimes coming as a shock even to able students. Indeed, there were some suggestions that the point of major point of transition was now between C1 and C2.

Some of the centres provide bridging units for students on the intermediate tier or encourage them to catch up on algebra independently before beginning the A level. One centre recognised that the C1 unit is useful in this regard but others felt that the GCSE provides only limited preparation for the level.

Some thought that there was too much time for C1 and not enough time for C2. As a result, some had changed their time allocations for these units. This would naturally have been limited, however, by the scheduling of the examinations for these units.

Some noted that the content of C1 was similar to or the same as parts of GCSE mathematics but that it in this way it helps students to make the transition to from GCSE to A level.

A couple of the teachers said that their students experience the progression from C1 to C2 as a more significant point of transition than the move from GCSE to A level. The teachers characterised this as better than previously because although there is still a ‘shock’, it ‘comes later now’ and it is ‘not as severe’ as under the Curriculum 2000 A level.

In 2006 the longitudinal questionnaire also asked centres for their views on the ease of transition from GCSE to A level, in response to a question asking whether the transition was now more difficult, less difficult or no different. Across all centres there was strong agreement (60 per cent) that the new specifications make the transition from GCSE to A level less difficult, with less than 4 per cent finding them more difficult. At centre level the modal response is ‘less difficult’ for all centre types, although this is equal with ‘no different’ in the case of further education.

On the more specific question of the transition between GCSE and C1, the pattern seen above was repeated even more strongly with almost 70 per cent feeling that C1 has made the transition less difficult from GCSE, at least 60 per cent of all centre types agreed that this transition was less difficult.

There was also a question about C1 to C2 transition. As a result of interim findings, in this case there was more of a divided view, 56 per cent felt the transition from C1 to C2 was easier than the previous P1 to P2 transition, with 30 per cent feeling there is no difference. Around 14 per cent felt the C1 to C2 transition is more difficult than before.

Transition: AS to A2

The large-scale questionnaire in 2006 contained a question about the progression from AS to A2 and the relative difficulty compared with the previous specifications. There is a less positive response to this question than to the equivalent question about the GCSE/AS transition. Around half the centres see no difference to the previous specifications, the remaining half are almost equally split between those who find the progression more or less easy than before.

Case study staff felt that although some weaker students would have dropped out before the second year, the transition to A2 was often difficult, ‘It is quite a shock to them when they start A2’ and, ‘The topics get significantly harder and they don’t expect that.’ The AS course is relatively easy and so there is not much to build on for the A2 course. Students who had lower grades in their AS modules were (unsurprisingly) more likely to struggle. Two schools taught A level as a two-year course (without taking the AS exams) and were not concerned about the AS/A2 transition.

A2 case study students questioned said that they were finding A2 more challenging than AS and they were working harder. On balance, however, the general tenor of comments was that the progression was manageable. They said it was a step up from AS and that there was greater depth in A2. Some found this a big jump. A couple of students said the jump from C2 to C3 was considerable. On the other hand, many students said they saw a progression from AS to A2 and felt that the AS had given them a basis for the work they were now doing. This was seen as good and bad, with some enjoying building on their prior work while a few others felt that their AS knowledge was assumed.

Teaching staff

The modal number of teachers in case study centres per A2 group was two, and in most cases the students were happy with their teachers and in some cases they were very enthusiastic about them. The qualities they appreciated in their teachers were being well prepared, experienced, knowledgeable and approachable. Injecting humour and promoting a relaxed atmosphere were also appreciated. It was seen as important to be able to have a dialogue with the teacher, being given explanations and being able to ask questions.

Where students made negative comments about their teachers, these included that they did not know their subject sufficiently well or were unapproachable. Some teachers were said not to make the lessons interesting enough. Some were ‘intimidating’. Other negative characteristics mentioned included assuming too much knowledge and not being prepared to go over things.

For AS groups the modal number of teachers was also two. While comments about teachers were predominantly good, students from 11 centres made negative comments about their teachers. Good characteristics were: explaining things well and ensuring everyone was keeping up, giving out good notes and making the classes interesting.

Negative characteristics varied more, and included: not acknowledging the range of abilities or understanding in a class, not taking the time to give a thorough explanation, not varying teaching and learning methods, too much talking, too much writing, not sticking to the point and giving too much explanation.

For the further mathematics students the modal number of teachers was three. The vast majority of comments about teaching were positive. Students commented on how teachers had different teaching styles. Good points were: using a mixture of approaches, taking time with explanations and making lessons interesting and enjoyable. A few students commented that further mathematics attracted the best teachers because it was a difficult subject. Others commented positively on how experienced or able their teachers were.

The few negative comments related to teachers going too fast or too slowly, not being approachable, not being interesting and giving too much homework.

Non-completing students in the majority of centres said it was easy to get left behind, particularly if they missed a lesson. They felt that there was no time to learn things properly and said that they forgot one thing when they moved on to something else. More than half of the students said that different teaching methods could have helped them to continue. Suggestions included better explanations from teachers, smaller groups and a slower pace of work for less able students.

This evidence on teaching is interesting to read in the context of the Ofsted report *Evaluating mathematics provision for 14–19 year olds*. Reporting research carried out in 2005, it found that ‘teaching was the key factor influencing students’ achievement’. The report criticised mathematics teaching in failing to promote ‘a really secure understanding of mathematical ideas, in stimulating students to think for themselves and to apply their knowledge and skills in unfamiliar situations’.

Of students concerns about teaching, listed above, the issue of thorough explanation and ensuring that everyone understands come through, both of which appear to link to the issues raised by Ofsted.

Ofsted also noted that the syllabus and examination-specific support materials produced for and used by schools and colleges were helping students to pass examinations, but not necessarily to think about the wider issues and concepts in which areas of study were cited. They commended use of the Standards Unit materials, as well as other more diverse teaching methods. It is worth noting that some of our case study schools and colleges had no knowledge of the Standards Unit materials.[14]

Preventing dropout

In the interim report we discussed evidence from the first survey on retention strategies that indicated that centres felt that the most successful retention strategies were increasing timetabled teaching time with untimetabled extra tuition time also seen as a successful strategy.

Non-completers from most centres were positive about the support available to them while they had been on the AS course but, as described above, more than half of non-completing students said that different teaching methods might have helped them to continue.

Suggestions included better explanations from teachers, smaller groups and a slower pace of work for less able students.

Teachers said they had a range of retention strategies for struggling students including one-to-one discussions, monitoring students' progress, mathematics workshops and revision days. These strategies already provide teachers with the opportunity to respond to the students' suggestions.

Reviewing this section on teaching, as well as the issues around recruitment and the targeting of more able students, it is interesting to note the high number of non-completing students who felt they could have been helped to continue with different teaching methods. As reported, they cited better explanations, smaller groups and a slower pace of work for less able students. Other groups also alluded to the importance of ensuring that the whole class understood, and even A2 students criticised teachers for assuming too much knowledge and not being prepared to go over things.

[14] DfES Standards Unit, *Improving learning in mathematics*, September 2005.

The issue of meeting the dual needs of less able students who are struggling with understanding, and trying to stretch able students, which the data suggests form the majority of most teaching groups, must be particularly challenging for teachers – especially given the rather mixed picture of whom teachers perceive as suitable candidates for A level mathematics.

Reactions to new specifications

The interim report was not able to draw deeply on actual practice in respect of the second year of A level study, so this is the first opportunity to review how teachers and students have found the experience of ‘A2’ and the full award.

The case study teachers were asked a general question about their experiences of A level mathematics this year and made a number of comments that suggest they had changed their provision in response to the new A level and were now familiar with the new requirements, and more confident about teaching the course.

As in the interim report, the dichotomy in the findings remains. They continue to be split between those teaching staff who welcome the move to decrease the content in the course to make it more manageable and those who see this, and its consequential change of a reduction in the number of applied units, as unacceptable.

The large-scale questionnaire gives an impression of the strength of opinion in regard to each issue. The case study centre material is used to provide more depth of information.

Most significant changes to the specifications

In 2006, in the large-scale questionnaire, respondents were asked in detail about a number of changes, but prior to these questions they were asked to name the two most significant differences between the old and new specifications, and to rate them as either ‘positive’, ‘negative’ or ‘neither’. Responses were coded into broad categories and then analysed.

- **At AS**. The most significant difference cited between the new and old specifications at AS was the balance of the subject area – shifting to pure, followed by the level of difficulty – becoming less difficult. Respondents were divided about whether these were positive or negative changes, particularly in relation to the balance between the different areas of mathematics.

- **At A2**. The most significant difference cited between the new and old specifications at A2 was balance of subject area – shifting to pure. This was viewed by the majority of respondents as a negative thing at A2.

- **Overall**. The two most significant differences cited about the overall changes to the specification were level of difficulty (perceived as easier) and balance of the subject area (shifting towards pure) – opinion was divided about whether this was a positive or negative change.

Within the case study centres, in response to questions about the new specification structure, almost all centres commented on the changes to the structure of the qualification, most of them being broadly favourable.

As in the large-scale questionnaire response, there was a mixture of teacher support for, and dislike of, the higher proportion of pure mathematics in the new syllabuses, the majority are in favour but a minority argued that the new structure offered less flexibility and ‘The applied part of the course has been diluted’ and ‘The A level is now two-thirds pure which they find hardest'.

There was general support for the reduced emphasis on mechanics, as fewer students now go into physics. Statistics is more relevant to other subjects, such as geography and economics.

There was also general agreement that mathematics required more time than other A levels and was viewed as more difficult. It was felt that the recent changes had reduced the gap between mathematics and other A levels.

Main impacts of the new specifications on teaching

The large-scale questionnaire in 2006 asked centres about the impact on teaching and on administrative arrangements. It also asked about time allocations for mathematics.

The overwhelming majority of respondents (92 per cent) said that the new specifications had had no significant impact in terms of staffing allocation, the remaining comments were very diverse with no key issues. This finding was also reflected in the case study data relating to staffing. Only three of the case study centres considered that any difficulties had arisen in staffing as a result of the change in specifications and these were fairly minor concerns related to individual staff who were no longer able to teach their preferred combination of modules. Two centres said that the reduced need for specialists in statistics and mechanics made it easier to arrange the staffing and several indicated that they were using the greater flexibility to broaden staff experience and give them a greater variety of modules.

The large-scale questionnaire also asked about impact on teaching style. Around 80 per cent of centres report no significant change to teaching styles, the remaining 20 per cent were divided, reference to the details indicates no strong patterns and some contradictions – ‘teaching is rushed’ and ‘more time’ each account for six comments.

In considering administrative issues raised by the specifications, the 2006 survey found around 80 per cent of centres had not had any significant problems in this respect, of the fifth of centres who did report significant new administrative problems, reorganisation of teaching load and updating of materials represent about a quarter of the issues named. Issues relating to examination organisation and resits accounted for around another quarter of issues cited. This is also in line with findings from the case study centres. Eight of these centres said that they had not encountered any administrative problems as a result of the change to the new specifications, and it was felt that a positive point was that it was now possible to complete the first three modules within the first year.

Of those reporting difficulties, there were concerns about new textbooks, including the cost, availability and quality, the need to rearrange teaching schemes and rewrite course notes, and the organisation of resits.

Despite claims that mathematics is harder than other subjects, the amount of time allocated to mathematics by those responding to the large-scale survey was almost always the same as that allocated to other A level subjects (94 per cent), with only five per cent indicating that more time was given to mathematics. Case study centres also, with one exception, said that the time allocation for A level mathematics was the same as for other subjects, quoting figures in the range of 8 to 10 hours per fortnight. The exception had chosen to have one fewer lesson in year 13 in order to release staff to teach further mathematics.

Accessibility/stretch

The large-scale questionnaire asked about this change in terms of two separate impacts in 2005 and in 2006 a single question was asked about this issue.

In 2005, 90 per cent of centres agreed that the new specification gave more time for students to acquire knowledge and understanding of the compulsory material, and around 80 per cent agreed that the reduction in content helped students learn the compulsory material more thoroughly. In 2006 we asked centres whether spreading the core content over four units has helped students secure a firmer and clearer understanding of the core material. Here, there was not such firm support for the question with 45 per cent agreeing that it did, another 40 per cent unsure if this was the case and 15 per cent felt that it did not.

A further question was asked in the 2006 survey about whether the two optional units provide sufficient stretch for the most able students. The majority of respondents to our survey (61 per cent) felt that the two optional units do *not* provide sufficient stretch for most able students, and 66 per cent of centres reported offering other strategies to provide additional stretch, including further mathematics, AEA and STEP.

Amongst case study centres interviewed on this issue, the majority view was that the new A level specification was more accessible to the less able student. Two people said this was because the level of prior knowledge needed was lower. Also, while the old AS level had required far more time than other AS levels, the new specification corrected this. A minority had not found the new syllabus more accessible. Most people approved of the more accessible AS level, accepting that it was desirable for more students to be able to take mathematics at this level. They considered that the new recruits to A level mathematics would probably not be the most able, but would still be able to benefit. By contrast, one teacher was strongly opposed to a reduction in standards and two doubted the value of a more accessible AS level, arguing that the less able should take an alternative course, such as use of mathematics or statistics.

In considering the issue of stretching the more able students in particular, most case study centres felt there was enough material in the new specification to stretch the ‘normal able’ student, but that the most able could be stretched only by doing further mathematics A level. Some centres had increased the numbers on their further mathematics courses to provide the necessary challenge and one also offered AS further mathematics as a less demanding extension, but one did not have enough staff time to do this.

As in the survey, case study centres were using additional strategies to provide stretch, such as extra questions in the textbooks beyond the requirements of A level. They were also using the AEA, the UK Mathematics Challenge, mathematics poster competitions and inter-school mathematics quizzes, encouraging the more able to ‘read around’ the subject and using links with employers to help students to see how mathematics was used in the real world. One put the brightest into subsets so that they could stimulate one another.

The great majority felt that they could meet the needs of a wide ability range by providing extension activities of these kinds to the most able, setting more demanding targets for the most able and also providing extra help for those who were struggling. One centre, however, considered that the weaker students should be able to do a ‘mathematics for business’ type course instead of the normal A level.

Maturation policy – spiral curriculum

In 2005 respondents to the large-scale questionnaire were asked for their views on the ‘spiral curriculum’ approach adopted in the new specifications, where a topic was introduced at AS level and then given a more sophisticated treatment at A2. Seventy per cent had felt that this approach was likely to be successful in 2005. In 2006 47 per cent agreed that this policy had given most students a better understanding of the topic, 45 per cent felt it had made no difference, and 8 per cent felt it had given most students a weaker understanding of the topic.

Case study centres were also asked about this approach for the interim report where there was quite a divided picture about its suitability and the problems of splitting up topics. When asked again in 2006 about this approach, staff at almost all the centres regarded this positively, considering that it enabled them to reinforce and build on what they had already taught. Sometimes it enabled them to show the link with topics from other modules, for example linking mechanics to integration. It was particularly helpful for weaker students. They conceded, however, that students did not always make the connections and that it was necessary for teachers to point out where a lesson was building on previous work. Students also need to see a use for the techniques. So, for example when teaching the technique of integration (C4) teachers needed to explain how it could be used, as this would only be taught later in the course. A few staff made neutral comments or regarded the change negatively, and the main criticism was that the course became fragmented.

As in the first report, one school was still using a linear approach to teaching and not sitting AS levels, but they planned to revise their teaching scheme for next year so that they would not be covering significant A2 material in year 12. Another school was only partially following the recommended approach.

Assessment patterns

Respondents to the large-scale questionnaire were asked about the assessment pattern that they adopted prior to September 2004. The overwhelming majority of centres (77 per cent) entered students for all AS units in the first year and all A2 units in the second year, with 18 per cent entering students for some AS units in the first year and the remaining AS and all A2 units in the second year. This pattern was the same in all centre types. When asked if the pattern was expected to change in the future, 62 per cent said that it would not, and 30 per cent said that it would. When asked how it would change half of the respondents replied that they would be completing all the AS units in the first year from now on.

In the 2006 survey, when asked whether students generally completed their AS in a single year in the 2004/5 academic year, the overwhelming majority of centres (96 per cent) said that they had. A comparison question asking about their practice in 2003/4 showed only 79 per cent had completed their AS in a single year, so a considerable shift has occurred.

Resitting

In general, the case study teachers thought that some students take too many resits for A level mathematics but a few pointed out that the number of students taking several resits is low. Some of the teachers reported that students sit C1 and C2, then develop their level of understanding in sitting C3 and C4, and then resit C1 or C1 and C2 to gain a higher score than in their first sitting. It was felt that students act strategically, retaking the easier early units.

This pattern of strategic resitting is supported by the awarding body data discussed above, and by the responses to the large-scale survey administered in 2007 that asked respondents about resitting behaviour in respect of assessment. Most indicated that the majority of resitting behaviour related to A level students resitting AS units, with around 30 per cent of centres indicating that between 71 and 100 per cent of their students resat units. Centres used June in the first year and all second year opportunities to resit AS units.

When asked about the type of students resitting, for AS only students the most frequent response related to lower quartile students (42 per cent), but for A level students resitting the most common response was ‘all students’ (40 per cent).

Generally, centres did not restrict the frequency of resitting, but where they did it was generally to a single opportunity. In terms of preparation for resitting, the picture generally indicates that candidates tend to be given past papers to work through on their own, and revision lessons outside of timetabled lessons are also provided by around half of centres.

When asked about why A level students resat AS units, there were several reasons that were rated as applying ‘often’ by over half the centres. These were ‘failure to get desired mark/grade on the unit’ (63 per cent), ‘maximising grade for A level qualification’ (66 per cent), and ‘maximising UMS (uniform mark scale) for A level qualification’ (59 per cent). In terms of A2 unit resitting, the most frequently rated reason for resitting occurring ‘often’ was ‘rarely resit’ (50 per cent), highlighting the focus on AS units.

The evidence from these questionnaires reinforces the picture drawn by the awarding body statistics described above, and also indicates the type of strategic behaviour that takes place in this respect.

Experience of assessment

The 2006 survey report contains detailed information about centre responses to the examinations for each unit. In terms of the core AS units there was a large majority (around 85 per cent for C1 and C2) who agreed that the examinations were ‘about right’, a similar number agreed that the C3 examination was ‘about right’ falling to around 70 per cent for C4 with 30 per cent finding it too demanding.

The case study centres were asked about their experience of examinations. A number of the staff interviewed mentioned differences in the examinations for the new A level. Several thought that the examinations are more accessible now and a couple mentioned C1 in this context. Opinions differed as to whether ‘more accessible’ meant a lower standard. Several centres were critical in these terms.

In terms of results, case study centres reporting on AS results from the summer 2005 series were divided in terms of numbers feeling that results were better or worse than expected. Most centres reported, sometimes tentatively, that the A2 results for summer 2005 were for the most part better than expected. The results of only one centre were as expected and only one centre had found that results were lower than expected.

Students were asked about their experience of examinations in interviews and in the questionnaire administered in January 2006.

A2 students' opinions were mostly split between finding the examinations harder than expected and finding them as expected. Only a few found them easier than expected. Most found at least one paper difficult. Where they found them harder, reasons given included that they were not fully prepared and that that the papers were different from specimen papers or from coursework. A few students said they found the wording of the questions difficult or confusing, which they said made it difficult to identify the methods they were supposed to be using.

About a quarter of the AS students said that they had not taken any AS examinations at the time of interview (one group had done mocks). The most common one to have been taken was C1. Two students had taken D1. The majority of students who made comments about the examinations they had taken were positive about the experience. Several said it was easier than they had expected and easier than the practice papers they had done. Some said they appreciated the preparation they had done by working through practice papers. In general they felt they had enough time to complete the examination.

Where a small number of students made negative comments about the examinations, about half said that they had found the wording difficult to interpret, meaning that it was not always easy to see what they had to do.

The student questionnaire focused on students' feelings about the results they had obtained – 57 per cent of year 13 students said their AS mathematics results were about what they had expected, 18 per cent said they were higher and 26 per cent said they were lower.

Boys were more likely than girls to say their results were as expected (61 per cent to 49 per cent), they were similarly likely to say they were worse than expected (25/26 per cent) but girls were more likely than boys to gain a result that was better than expected (25 per cent to 13 per cent). This may link to the comfort hypothesis.

A* students were more likely to gain A level results that were better than expected and A–G students were more likely to gain results that were worse than expected. One possible explanation for this is differing work ethics and motivations of these different types of students.

Choice and applied units

The teachers on the whole seemed content with the choice of optional units available to students. When asked about limiting the students to a choice of just three routes (mechanics, statistics or decision mathematics but no combinations), some of them were not sure that it would be feasible because of timetabling and setting constraints but one teacher thought that it would work.

In the interim report about half of the case study centres offered no choice of applied unit to their students (S1 then S2, M1 then M2, S1 and M1, D1 then S1). The most common offer – M1 and S1 only – gives students no choice of units (six centres). Two centres offered only S1 and S2. No centres offered only M1 then M2. At the case study seminar in early 2007, which did not represent all centres, most were offering two AS and A2 optional units in combination with each other. One of these centres is large enough to provide the full range of AS/A2 choices and is also offering students the opportunity to take two AS optional units (D1 and S1). A couple of the centres were offering only the AS optional modules S1 and M1. The size of their centres prevented them from offering a choice. One said that whichever order S1 and M1 were taught, the first one was problematic. A couple of centres said the less able students were guided into D1 and D2 but one said that this was less the case than since 2004.

The reality of choice and the ability to tailor the mathematics A level to the needs of the student seems really only to be true in large centres where the resources and scale exist to provide a choice at the level of the student. In many cases it appears that the student is stuck with the teachers' choices, whether this is appropriate for them or not. Students who are also taking further mathematics will – of course – have access to a wider range of units, although there may be no further element of choice for them.

Further mathematics

This section discusses evidence from the large-scale 'participation in mathematics' questionnaires, which asked a number of questions about further mathematics in all three years.

Over the three years of surveys, there has been a rise in the proportion of centres offering AS further mathematics from 73 per cent in 2005, to 76 per cent in 2006 and now 86 per cent in 2007 (non-matched data). Over each of these years the most frequently reported reason for not offering further mathematics has been the lack of student demand.

In terms of numbers of students studying further mathematics at AS level, in the matched questionnaire sample there has been an increase from a mean of six in 2005 to nine in 2006. The unmatched data shows exactly the same figures. In addition, the data show that, within the respondent sample, over the years there has been a net rise in the percentage of the AS mathematics cohort that is studying AS further mathematics, from 11 per cent in 2005 to 13 per cent in 2007. In 2006 the figure reported was eight per cent so this is not a stable trend for this sample.[15]

Looking at the same questions in terms of A2 gives a similarly positive picture of provision amongst those responding to the questionnaires. The proportion of centres offering A2 further mathematics has increased from 71 per cent in 2005 to a reported 90 per cent in 2007, which is bizarrely higher than those reportedly offering AS. It is likely, however, that this is the result of an order effect. The question about whether AS was offered came first in the 'Further mathematics' section of the questionnaire, it is likely that those not offering AS moved on to the next section. Certainly, more participants completed the AS question than the A2 question, indicating that the A2 respondents are a subset of AS.

An analysis of the questionnaire data relating to the A2 further mathematics cohort, in terms of the A2 mathematics cohort, shows a 2007 total of 18.3 per cent, this figure was 20 per cent in 2006 and 18 per cent in 2005 for this sample.[16]

An additional question in 2007 asked centres about the amount of time that they allocated to teaching the further mathematics qualification. In contrast to the similar questions relating to AS and A level mathematics, the responses to the question about AS further mathematics was a huge spread with 64 per cent of centres allowing between 201 and 600 minutes per fortnight, the same spread was shown at A2.

Within the case study centres almost all were offering further mathematics in 2006. A minority offered further mathematics as an accelerated course in year 13.

Some teachers thought there had been a dilution of further mathematics and that it may not now provide enough preparation for related university courses if AS optional units are taken. Where views were expressed, teachers felt that the most able should be

[15] This information relates to students studying, rather than examination results. National examinations data do show a stable upward trend over this period, see http://www.fmnetwork.org.uk/manager_area/files/1analysisofFMNimpact.pdf.
[16] This information relates to students studying, rather than examination results. National examinations data do show a stable upward trend over this period, although at much lower proportions, see http://www.fmnetwork.org.uk/manager_area/files/1analysisofFMNimpact.pdf

encouraged to do further mathematics and the most able can only be stretched through this route, and in some cases only by using A2 optional units towards further mathematics.

A few centres are encouraging more students to do further mathematics but resourcing may be an issue at small centres.

Further mathematics students were enjoying their course and finding the work interesting.

Other

AEA

In 2006 the large-scale questionnaire contained questions about the AEA, which revealed that it was offered in only about a third of centres. When asked about why the AEA was not offered, a variety of factors was offered. Lack of time or workload factors are cited most frequently, but the remaining high scorers indicate a lack of confidence in the AEA as centres offer STEP as an alternative, AEA is not seen as a requirement for higher education and further mathematics is seen as more important and useful. Teacher ignorance of AEA is also evident.

The questionnaire also contained a cluster of questions to investigate whether students taking an accelerated A level would be entered for the AEA in the same year, the evidence showed that the majority were not, and waited until their second A level year to take the AEA. Respondents were equally split about whether the delay affected their performance. The comments indicate that teachers consider that students benefit from the maturity of waiting and their further learning (it is presumed that they will generally be taking AS or A level further mathematics in their second year of A level).

Two-tier GCSE pilot

Only one of the case study centres participated in the pilot of two-tier GCSE mathematics. This centre’s head of department took the view that the pilot would not have an impact in A level mathematics, as the centre’s entry requirement would continue to be grade C or above.

Some of the centres not involved in the pilot gave their views of the possible impacts of the two-tier GCSE on A level mathematics. A few of the teachers interviewed were expecting more higher tier students and therefore more students considering mathematics as an A level option.

