Qualifications and Curriculum Authority

Evaluation of participation in A level mathematics

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We have received an enormous amount of help and encouragement with this project during its first year, and we would like to extend our thanks to a number of people.

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1. Introduction

The new AS and A level specifications that have been in use since September 2004 are a response to points made by QCA's own internal investigations reported in Professor Adrian Smith's inquiry about the existing GCE AS and A level (Curriculum 2000) awards. These centred on issues of overload, and concerns were expressed about the effect of these new awards on take-up of mathematics at A level.

There is no doubt that numbers participating in mathematics at A level have declined over recent years. Currently approximately 50% of the GCSE cohort achieve mathematics at grades A*–C, a figure of around 300,000. However, in 2004 only about 63,000 went on to take AS level: of these about 41,500 sat the A level with about 66% of the total taking AS and only about 14% of the GCSE cohort achieving A*–C.

This study will seek to identify ways in which take-up and retention might be increased. It is hoped that the current downward spiral in numbers will be reversed as teachers and pupils feel the effects of the new specification.

Since it is too early to assess the success or failure of the new specifications in terms of their impact on student numbers or levels of achievement, this year we have focused on establishing an effective baseline of information about GCE mathematics students.

The study uses both qualitative and quantitative methods, ranging from detailed work with 19 case study centres, looking in detail at both teacher and student responses to AS and A level mathematics, to national cohort data that is matched at candidate level, in order to examine performance at AS and A level mathematics qualifications in as much detail as possible. In addition, we have undertaken a large-scale survey of centres, with around 200 schools and colleges responding to our questionnaire. This focused on centres' history of take-up of mathematics A level as well as their response to the new specifications.

It is important to note that the focus of this project is limited solely to an examination of AS and A level, but it is clear from this work that problems with motivation and choice start before A level – many staff, both in visits and through questionnaires, have mentioned GCSE and mathematics in the national curriculum as problematic, in terms of retaining students' interest and motivation. The QCA mathematics team has a large programme of work in hand looking at mathematics across the national curriculum and GCSE and GCE. It is essential that all aspects of this work are cross-referenced to ensure that they inform each other.

2. Summary

In reviewing the data gathered for the first year of the project, several key issues have emerged.

The first is the 'clever core' of mathematicians at A level and the impact of this phenomenon on recruitment to, and attitudes about, A level mathematics.

The second issue is the fundamental disagreement between those involved in delivering the mathematics A level about what its purpose should be, and therefore their attitudes towards it.

Both of these will be discussed in more depth below.

In addition to these themes, this summary will look at some of the emerging messages about the new qualifications, as well as some of the strategies that appear to be successful in retaining students' commitment to A level.

We will also discuss the possible ways in which some of the findings might inform strategies aimed at increasing total recruitment to A level mathematics, and strategies for appealing to different genders and those with different ability levels.

Clearly, this year's work has been aimed at establishing baselines, rather than making any definitive statements about the impact of the new qualifications. However it has revealed some clear messages about A level mathematics which can be used to inform future policy in a positive way.

The clever core

In reviewing the national statistics about achievement at A level, using both the matched candidate data and the Joint Council Statistics (Appendices A and B), a clear picture emerged of a decline in the numbers of students achieving A level mathematics, but at the same time of a high standard of achievement being maintained with a very high proportion of students achieving A grades. In the last five years, mathematics' overall share of A level students has declined by about 7,000 students, but in the same period it has increased its number of A grades by about 3,500.

Analysis of average GCSE point score revealed that mathematics and further mathematics students were the highest attaining of any of the comparison subjects that we looked at. The data indicate that the students who have continued with mathematics A level over time are the high achievers, and that those who have either decided not to take A level mathematics, or who contribute to the high level of attrition during AS study and between AS and A level, are the less high achievers who would be gaining grades other than A, had they continued their study.

There are a number of apparently contributory factors to this pattern of take-up by the 'clever core', and lack of take-up more widely:

- weaker students' negative experience of mathematics at GCSE
- mathematics' reputation as more difficult and higher risk than other A level subjects
- targeted recruiting of top set GCSE mathematics students only.

Disagreement about the purpose of A level mathematics

It is clear from the work carried out so far, that there is a split in the opinions of teaching staff about the role of A level mathematics and also in their reactions to the new specifications. The split does not seem to be easily reconcilable. One group of teaching staff sees A level mathematics as being a subject where the maintenance of a high level of demand and wide scope of content are paramount. This group views any moves to make the qualification more accessible by reducing the amount of application and increasing the number of core units, as an unacceptable 'dumbing down' of A level mathematics, and something that makes it unattractive to their very able students. Other teachers see the reduction in content as a positive move in terms of helping all students to succeed, which they see as key. They prioritise all students covering the pure content.

A clear piece of evidence from our study illustrating this division in opinion was gathered from our large-scale survey. The reduction in content in the new specification achieved both the most positive and the most negative feedback. For those who were positive about the reduction it meant increased time to cover the material; for those who were negative it meant reduction in demand and loss of opportunity to challenge able students.

The two issues discussed above are likely to feed each other, at least to some extent. The relatively high demand of mathematics means that its appeal is necessarily restricted to those students who are able in the subject, the 'clever core'. The students studying A level mathematics who have achieved very high scores in GCSE mathematics indicate that the

most important reason for selecting mathematics is their enjoyment of the subject: they study mathematics because they like it and probably enjoy being stretched in their subject.

However, by stretching those students who are very able in mathematics, it is possible that a strain is placed on those students who find the subject more challenging. Students studying A level mathematics who achieved lower grades in GCSE mathematics indicated that they are more likely to have selected the subject because they needed it, rather than because they enjoyed it. Those who did not select mathematics A level in our study, despite having good GCSE grades in mathematics, gave as main reasons both its notorious difficulty and their lack of confidence in their ability, with some saying that they were not encouraged to consider it by teaching staff.

It is the second group of students, those who are less strong, that must be appealed to if A level mathematics is to increase its participation and achievement rates significantly.

It is unlikely that there is a 'middle way' between the two positions described and it may be worth undertaking work aimed at trying to establish a way forward so that there is mathematics provision at A level that both meets the need of providing a qualification of comparable demand to other A levels, as well as providing a challenge to those students who are very able in the subject. It is not likely that both these aims can be met within a single coherent award; perhaps further mathematics may be helpful here.

An interesting adjunct to this section is that some staff responding to our surveys and interviews cited the needs of higher education (HE) as a reason to maintain the high demand of A level mathematics. It has been suggested that there is evidence that the HE mathematics community is not concerned about the reduction in content, and this could be an important message to promulgate to help reconcile teaching staff to the new content.

Emerging messages about the new specification

Although it is too early to make any firm statements about the new specification, there are some emerging messages that are worth highlighting, and these are generally positive. These will be explored in more detail in subsequent stages of the project.

1. Most teaching staff, both in case study centres and in responding to the large-scale survey felt that the new specifications have allowed more time for students to learn the compulsory material thoroughly. About half of the case study centres also indicated that there had been some improvement in the transition from GCSE to A level mathematics.

2. Half of the case study centres indicated an apparent reduction in non-completion that they attributed to the new specification, with a similar proportion of centres also expecting more continuation from AS to A2 than in the previous year.

3. Almost all centres will be able to deliver the AS award in a single year, owing to the reduced content. It will be interesting to see whether this has an impact on retention to A level. It is possible that the students will be motivated by their achievement to continue with the subject, or there is a possibility that by being given a break between awards at the end of the first year of study they may be inclined not to complete the A level. This will be monitored in subsequent years. Interestingly, one case study centre uses a strict linear approach to mathematics, one aim of which is to retain students for the whole A level. Analysis of grade achievement through linear delivery indicates that it offers no incentive in terms of quality of outcome.

Possible further strategies for increasing participation

Although the new specifications are aimed at increasing participation through reduction in content and other changes, analysis of the data so far suggest that there may be other ways of improving recruitment and retention for A level mathematics.

1. More focused information, advice and guidance by gender and ability

Gender: Evidence from students gathered in the survey, and replicated in studies by both Fiona Allen[1] and Anne Williamson[2], indicates that there are some gender differences in the reasons for choosing to study mathematics at A level. We have termed these two gendered themes ‘utility’ and ‘comfort’. Boys stressed factors around usefulness of mathematics more frequently than girls, and girls stressed factors around enjoyment and coping more frequently than boys.

These findings do not indicate a dichotomy between the students. Girls still find the usefulness of mathematics important, but they also appear to be more concerned with being comfortable about their ability to cope. Likewise, boys do think it is important that they can cope, but they are more concerned that they will have a useful qualification. These tendencies could be played to in guidance.

In terms of girls in particular, the data discussed in the findings section indicate that there is less success in recruiting girls to AS and A level mathematics than boys, comparing

GCSE participation and success rates with mathematics; providing a more 'female friendly' message may be helpful.

Ability: analysis of reasons for choosing mathematics based on students' grade achievement at GCSE showed that 90% of the A* GCSE mathematics students cited coping well at GCSE as a main influence. B and C grade students, indicating that choice was more based on necessity in their cases, highly rated issues around utility of the qualification more frequently than any other students.

In terms of ability it is interesting that the utility theme is more pronounced in those students with lower grades at GCSE. Other evidence from the study suggests that the utility of mathematics is not well understood by many students, especially those who do not choose to study A level mathematics. Guidance for the apparently less mathematically able students could be targeted to highlight the usefulness of mathematics in future careers and study.

2. *Targeting a wider group of students*

It is important to note that teachers responding to both surveys and to case study interviews often cited a targeted recruitment population that was restricted to only the top set of GCSE mathematics students. In many cases, and there were sharp differences between centre types, students taking the intermediate tier at GCSE were not encouraged, or allowed in some instances, to take A level mathematics. This restriction of potential candidates may have led to the embedding of the 'clever core', and lack of expectation of a wider ability range at A level.

Teacher encouragement is a key factor in student choice of subject. Students feel more confident in their ability to succeed if they are encouraged to do A level by their mathematics teachers. Since most mathematics teachers appear to focus their efforts only on the top sets, it may be helpful to consider a wider prospective group.

3. *Increased timetabled time for mathematics A level*

This was cited as the most positive way of increasing retention by centres responding to the large scale survey. This is interesting since, in effect, the reduction of the content in the new A level will increase the amount of time available to cover the material, producing the same effect as increased timetabled time had on the previous specifications. If this is the case, we may predict increased retention as a result of the new specification.

Future indicators of increased participation in mathematics

As well as seeing an increase in numbers achieving at A level mathematics (in 2004 A level mathematics entry was only 8% of GCSE mathematics entry) there are likely to be other indicators of an increased take up of A level mathematics in the future. These will be important in terms of predicting the longer-term impact of measures introduced to help increase participation in mathematics.

1. More democratic grade distribution and GCSE point score

The 'clever core' theory describes the current cohorts of A level mathematicians as high achievers who enjoy and are good at mathematics. They have continued with A level mathematics over the years whilst those beyond the clever core have chosen other subjects or left mathematics at AS. If the new specifications and other strategies to encourage recruitment are successful, we would expect this core to become augmented by other students so that the difference between average GCSE point scores for mathematics' and other students becomes less marked, and thus the grade distribution for A level mathematics will become less 'top heavy' with wider distribution across grades other than A. There should still be at least the same number but a lower proportion of A grades, but a larger cohort overall achieving at all grades.

2. Conversion rates from AS to A level should improve

The current poor rate of conversion of AS students to A level students should increase if students find the AS more accessible and if they are encouraged to move to A level. There should also be less in-course attrition.

3. Less negative perception of mathematics A level amongst students

If A level mathematics students' experience is improved, and the new qualification is felt to be more accessible then there will be a transmission of this experience to potential students. Older students are seen as key transmitters of information about courses, and the reputation of A level mathematics was very poor amongst students interviewed. This point may equally apply to media messages.

4. Impact of two-tier GCSE system

Depending on the success of the two-tier GCSE system, there is likely to be some feed-through to recruitment at A level. Our study this year indicated two main areas where the current three tier system led to problems for recruitment and retention.

Firstly, there was the perception amongst young people themselves that if they had not taken the higher tier at GCSE then they would not be able to cope with A level, despite achieving up to a grade B. This problem of self-doubt should be ameliorated by the two-tier system, since the students gaining grade B will have achieved at the higher tier.

Secondly, there was the reality that intermediate students, even with the same grade, did not appear as likely to achieve at AS or to continue to A level, according to staff responding to the large-scale survey. One reason why intermediate students may not perform as well as those who have taken the higher tier is that they are not exposed to the higher tier material and are thus at a disadvantage in terms of coverage. The two-tier system will mean that the students with access to grades B and above are exposed to the higher tier material, and so this situation should improve.

3. Overview of related work

This evaluation is being undertaken in response to the issues raised by Professor Adrian Smith's inquiry of February 2004[3], which itself built on the findings of Sir Gareth Roberts' Review of April 2002[4].

The Smith report has resulted in a number of different areas of research and development work being instigated by the Department for Education and Skills and undertaken by the Qualifications & Curriculum Authority. Amongst other work being undertaken is the piloting and evaluation of a two-tier GCSE in mathematics, which will replace the current three-tier model in September 2006. Decisions are currently being made about the detail of the model that will be adopted.

In addition, there was a strong recommendation in the Smith report to investigate the feasibility of making GCSE mathematics either a double award (like science), or two single awards (like English language and literature). Possible options in this area are currently in consultation together with other initiatives in the field for making GCSE more accessible, including additional curriculum time in key stage 4. QCA will shortly present a paper to the DfES requesting a decision from Ministers.

A further issue raised as key by Professor Smith was the lack of properly qualified mathematics teachers. The DfES have placed a contract to investigate this issue and to try and formulate a strategy to increase the supply of qualified teachers of mathematics. 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, Professor Smith's comments relate particularly to teaching lower down in the education system.

Smith also raised the issue of ensuring that there is sufficiently stretching material to provide a challenge to those students who are very able at mathematics, both in GCSE and GCE, and recommended that attention was paid to this issue. QCA's post-14 mathematics work is considering whether changes are required 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 Advanced Extension Award, designed for the most able GCE students.

Concern was expressed by the Smith inquiry that the nature and frequency of assessment in the AS/A2 structure of GCEs was not appropriate to mathematics. QCA's post-14 mathematics Pathways project contractors will be considering the frequency and style of GCE assessment as they develop proposals for revised curriculum and assessment pathways for post-14 mathematics. QCA will subsequently make recommendations for the future of GCE mathematics, with first teaching likely to be from 2010 or 2011. In the short term, there is no plan to revise GCE specifications from six to four units. This study of take-up will separately monitor the extent to which revisions to GCE mathematics are leading to a restoration of earlier levels of participation.

Another study that is currently in place, and which is of interest to this project is being carried out with funding from 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 HE. The project has influential sponsors including the Institute of Mathematics and Its Applications (IMA), Royal Statistical Society (RSS), and Heads of Departments of Mathematical Sciences in the UK (HODOMS).

4. Findings and discussion

4.1 Sources

QCA's evaluation of GCE A level mathematics draws on a number of different sources of evidence: 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.

Despite the high profile reviews looking at the question of participation and retention in mathematics, there have been surprisingly few pieces of published research looking at the issue of A level mathematics, and in particular involving students in the research. This study drew on two small unpublished pieces of work, Anne Williamson's local survey of students in York[5] and Fiona Allan's report on 'Why students choose to study AS-level Maths'[6] to help inform the development of the student questionnaire.

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 C2K 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:

2001	Legacy A level	Curriculum 2000 AS	
2002		Curriculum 2000 AS	Curriculum 2000 A level
2003		Curriculum 2000 AS	Curriculum 2000 A level
2004		Curriculum 2000 AS	Curriculum 2000 A level

In addition to information about mathematics, information about English, physics and geography is included to provide a point of reference and comparison. For further information about these analyses, and for full results, see Appendix A.

It had been hoped that some national data would have been available to give a high level picture of within programme attrition. However the current Pupil Level Annual Schools Census (PLASC) that provides information about young people in schools for the matched candidate database does not contain information about student programmes. Although there is some information in the case of young people studying in colleges from the Individual Learner Record (ILR) this is not unproblematic since AS and A2 are registered as 'separate events', thus it is not possible to identify 'intention' to study full A level. This means that only attrition within the programme can be measured (that is, those students who start a qualification – AS or A2 – but fail to complete). Although this information is of some interest, it does not represent a breadth of either centre or student type very effectively. The issue of within year attrition, as well as intention to complete the full A level, was investigated in this study through the use of a large-scale survey (see below). It is likely that the ILR will be included in next year's report as additional evidence.

Joint Council for Qualifications Inter-Awarding Body Statistics

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

Cambridge Assessment Analysis of subject combinations

Research was commissioned on student subject combinations to see whether those involving mathematics have changed over time. For full results see Appendix C.

Cambridge Assessment Analysis of assessment – GCE mathematics as a linear award

This was commissioned from one of the GCE mathematics awarding bodies (OCR/UCLES) and is a limited investigation of 2004 mathematics GCE data looking at students who take all assessment at the end of their GCE course. For full results see Appendix D.

Analysis of QCA participation in A level mathematics questionnaire

This was a large-scale questionnaire sent to a random and representative sample of centres, supplemented by an on-line questionnaire that was publicised through various routes. Of the 191 respondents, over 93% agreed to be contacted again in subsequent years, allowing a longitudinal aspect to the project. Full details are at Appendix E.

The questionnaire was developed to address the main issues of the extent of current participation and drop-out of AS and A level mathematics students, as well as to look at the efficacy of various strategies in encouraging retention and participation. In addition, the survey asked about centres' reactions to, and experience of, the new specifications. The questionnaire was trialled and discussed in detail with three schools and was revised in line with feedback prior to distribution.

Case study centres

Case study schools were drawn from a Schools Co-ordinating 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 2004. Mathematics specialist consultants visited them in February and March 2005, and teaching staff were interviewed by telephone in July 2005. There are a number of different sources relating to these centres:

a. Staff questionnaire – December 2004 (full details are at Appendix F). This questionnaire focused on background information about the centres' participation and drop-out rates for GCE mathematics, as well as some information about the teaching staff.
b. Case study centre student questionnaire – December 2004 (full details are at Appendix G). This questionnaire was drawn up to look, in particular, at issues around reasons for choosing to study GCE mathematics.
c. Staff interviews – February/March and July 2005 (full details are at Appendix H.) 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.
d. Student interviews – February/March 2005 (full details are at Appendix I). Interviews were held with:

- AS students
- A2 students
- A level students who had dropped out from GCE mathematics courses
- A level students who gained good grades in mathematics at GCSE (at least grade B) but had chosen not to do mathematics GCE.

Interview schedules were designed to be common, wherever appropriate, so that responses could be easily compared between groups. In addition, specific questions were targeted at each group, to provide insight into any particular issues that may have been relevant only to them (full details are at Appendix M).

4.2 Participation – historical

The issue of participation in GCE mathematics is considered at various levels in the project. National results data are used to provide an insight into the overall patterns of participation over time (2001-2004), and the large-scale questionnaire and case study centres are used to try and get a sense of centres' experience of participation. All these sources are discussed below and reported in detail in the detailed 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 2001-2004. 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 level). 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% in 2001 to 44% in 2004.

The most striking increase is the proportion taking AS only, which has almost doubled from 3.7% to 7.3%. 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 thus 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 three comparative subjects (English, physics and geography) within this context. Table 1 (below), shows how these subjects have fared over time as a proportion of all A levels taken.

Table 1 - A levels taken

	2001 %	*2002 %*	*2003 %*	*2004 %*
All A levels	100	100	100	100
mathematics	9.0	6.8	6.6	6.7
further mathematics	0.9	0.7	0.7	0.7
English	12.5	11.5	10.9	10.8
physics	4.7	4.4	4.0	3.7
geography	5.8	5.1	4.9	4.6

All the comparative subjects and mathematics have dropped their share of the total A levels taken, although it is clear that mathematics has taken the most severe fall of all subjects considered, dropping from 9% to below 7% between 2001 and 2004. The subjects that have gained over this period are ‘newer’ subjects such as psychology, ICT and media.

In the same period there has been a 1% increase in the proportion of A level mathematicians taking further mathematics. It may be that the decreasing overall proportion of mathematicians described in table 1 has been lost at the less able end of the spectrum, and therefore able mathematicians who also take further mathematics now represent a larger proportion. An analysis of the average GCSE point score of A level students appears to support this: there has been a slight increase in the average GCSE point score of mathematics students over time; this has not been the case for further mathematicians.

Take up of A level mathematics by A level students

Table 2 – proportions of students taking A levels

	2001 %	*2002 %*	*2003 %*	*2004 %*
A level students	100	100	100	100
mathematics A	24	17.5	17.2	17.7
further mathematics A	2.3	1.8	1.8	1.9
English A	33.3	29.7	28.3	28.4
physics A	12.7	11.4	10.4	9.6
geography A	15.4	13.2	12.7	12.2

The decline in the proportion of individuals taking mathematics at A level is striking in Table 2: from 24% in 2001 to 17.7% in 2004, a 26.3% drop. This is mirrored in physics (24.4%) and geography (22.1%), whereas the magnitude of the drop in English was much less (12.3%). Further mathematics has shown a drop from 2.3% to 1.9% over the period, which represents a 17.4% drop.

Take up of AS mathematics by AS level students

Table 3 – proportions of students taking AS only (not achieving A level)

	2001 %	2002 %	2003 %	2004 %
AS only students	100	100	100	100
mathematics AS	15.6	13.2	12.5	12.4
English AS	17.4	24.1	23.2	23.2
physics AS	7.9	8.4	8.0	7.8
geography AS	6.4	8.4	8.3	7.7

Table 3 shows students who achieved one or more AS qualifications, but no full A levels. Over this period the comparison subjects have either remained relatively stable around their 2001 figure or increased their share – English improving from 17.4% to 23.2% (a gain of 25%), physics declining from 7.9% to 7.8%, and geography rising from 6.4% to 7.7% (a gain of 20%). Mathematics however, has shown a marked decline from 15.6% to 12.4% (a decline of 20.1%).

Take up of AS mathematics by A level students

Table 4 – Proportions of students taking at least one A level, but only an AS in comparison subject

	2001 %	2002 %	2003 %	2004 %
A level students	100	100	100	100
mathematics AS	3.4	8.3	7.2	6.7
further mathematics AS	0.9	0.8	0.7	0.9
English AS	0.9	6.1	6.2	6.2
physics AS	0.8	3.4	3.5	3.6
geography AS	0.5	3.5	3.3	3.1

Table 4 shows students who have taken full A levels in one or more subjects, but only an AS in the named subject. This may be regarded 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 students than other subjects: 3.4% compared with less than 1% in the other subjects. Over time mathematics has increased its proportion of students to 6.7%, a gain of 97.1%. English has seen the largest increase in this category, gaining from 0.9% to 6.2% from 2001 to 2004, a gain of 588%. Both physics and geography have seen large increases in the proportions they have in this category, physics from 0.8% to 3.6% (an increase of 350%) and geography from 0.5% to 3.1% (an increase of 520%). Further mathematics has not increased its proportion of students at all in this time period.

Although these gains look encouraging at one level, it is worth looking at them in the context of Table 2 where all the comparator qualifications have shown a decrease in their overall share of full A levels taken. It is likely that those qualifications that have seen the increase in take up of the full A level are the 'newer' qualifications that may initially have been chosen as the 'fourth' AS, but were carried on to A level at the expense of subjects such as mathematics, English, physics and geography.

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 5) shows mathematics and physics having the lowest 'conversion rate' from AS to A2; their A levels representing a lower percentage of their total AS students than the other subjects. Generally mathematics has had the lowest rate of conversion over the 4 years, although physics showed a slightly lower rate than mathematics (65.2% compared with 66%) in 2004. The 2004 rates compare with 72.5% in English and 72.3% in geography. This shows a higher proportion of AS students deciding not to continue with mathematics and physics to full award than in other subjects.

Table 5 – A level as a proportion of AS – all subjects)

Subject	2001 %	2002 %	2003 %	2004 %
mathematics	82.6	62.1	64.1	66.0
English	92.4	74.1	72.6	72.5
physics	88.2	69.6	67.3	65.2
geography	92.8	72.4	72.2	72.3
further mathematics	68.4	68.9	70.4	68.4

Student prior attainment

Looking at students' average GCSE point score for all comparator subjects shows that mathematics students have the highest average point score in every group: AS only, A level achieving an AS, and full A level. Only further mathematics students have a higher average GCSE point score. The table below shows the comparison for A level students. The average GCSE point score is relatively constant over time in all subjects, but has risen most in mathematics.

Table 6 – A level students (average GCSE point score)

	2001	2002	2003	2004
All A level	5.9	5.8	5.9	5.9
mathematics	6.5	6.6	6.7	6.7
further mathematics	7.1	7.1	7.1	7.1
English	6.0	6.0	6.1	6.0
physics	6.5	6.5	6.6	6.6
geography	6.1	6.1	6.1	6.2

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

These data are drawn from the published Joint Council for Qualifications Inter-Awarding Body Statistics. They therefore exclude candidates who would have appeared in the provisional results but who subsequently declined their grade. This data goes back to 1999 for full A level, compared with 2001 for the matched candidate data discussed above.

Table 7 - AS – Percentage of entry gaining A-E

Year	maths AS	English AS	geography AS	physics AS
2001	66.6	92.8	86.5	83.0
2002	81.7	94.7	91.7	86.6
2003	82.7	95.2	91.9	85.6
2004	84.6	95.5	91.7	85.8

Table 7 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 AS results in Table 7 are for certificated AS qualifications only, and thus exclude those students who declined their certification. This may have had the effect of emphasising the failure rate. It is possible that good students who performed less well than they expected decided not to accept their AS and continued the A level, hoping to improve through re-taking; whereas those with poor results, including failures, may have decided not to continue with the full award and therefore may have accepted their certification. The figures in Table 8 support

this hypothesis, showing a large decrease in A level entry in 2002, as well as the percentage A–E figures in Table 9 which show a remarkable improvement in 2002.

Table 8 - subject entry over time as a percentage of 1999 entry – A level

Year	maths A	English A	geography A	physics A
1999	100	100	100	100
2000	96.1	95.5	89.4	94.8
2001	96.2	93.2	88.9	95.4
2002	76.9	87.8	81.8	91.7
2003	79.8	88.0	83.1	88.6
2004	82.8	88.6	79.5	82.7

Table 8 shows A level subject entry over time, as a percentage of 1999 for A level. There is 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 some recovery in numbers since 2002, so that mathematics entry is now 82.8% of its 1999 amount. This is the same proportion as physics – although physics has seen a more prolonged decline, less than English (88.6%) and more than geography (79.5%).

Table 9 - A level – Percentage A–E

Year	maths A	English A	geography A	physics A
1999	89.8	92.7	92.8	89.8
2000	90.2	93.2	92.7	89.9
2001	90.2	93.9	93.2	89.9
2002	95.4	98.4	98.0	94.3
2003	95.7	98.6	98.1	94.3
2004	96.4	98.6	98.4	94.9

In Table 9 both mathematics and physics show markedly lower achievement at A–E than English and geography. All subjects show an increase in pass rates over time. Note there was no drop in achievement in 2002 of a similar order to that seen at AS in 2001; rather there was a substantial increase in pass rates (from 90.2% to 95.4%).

Table 10 – AS – Percentage A-C

Year	maths AS	English AS	geography AS	physics AS
2001	44.6	62.7	60.7	58.7
2002	58.1	63.6	64.6	61.3
2003	59.7	62.0	64.0	59.1
2004	61.4	63.2	64.5	59.4

Table 10 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.

Table 11 - A level – Percentage A-C

Year	maths A	English A	geography A	physics A
1999	65.3	58.5	62.8	63.6
2000	66.1	59.6	64.1	63.8
2001	65.5	61.2	65.1	63.7
2002	75.8	70.7	71.9	67.0
2003	76.8	72.2	74.1	67.4
2004	78.2	72.0	75.5	69.2

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 11, with mathematics rising from 65.5% to 75.8% and English from 61.2% to 70.7%.

Table 12 – AS – Percentage A

Year	maths AS	English AS	geography AS	physics AS
2001	20.9	17.5	20.2	24.6
2002	29.4	18.0	23.4	26.2
2003	29.7	16.9	23.3	25.3
2004	31.3	16.9	23.4	25.0

It is interesting to note in Table 12 that, even for the first Curriculum 2000 AS in mathematics in 2001, mathematics students still gained proportionately more A grades than either English or geography. The difference between mathematics and English is extremely large by 2004 31.3% for mathematics and 16.9% in English.

Table 13 – A level – Percentage A

Year	maths A	English A	geography A	physics A
1999	29.2	15.4	16.7	24.6
2000	29.8	16.0	18.1	25.1
2001	30.2	17.0	19.5	25.3
2002	40.3	19.3	21.0	27.8
2003	40.6	20.6	23.6	28.2
2004	41.9	21.3	24.7	29.6

The difference between mathematics and other subjects shown in Table 13 (percentage of A grades at A level) is extremely marked, with over 40% achieving A grades since 2002 in mathematics, compared with the high of 29.6% in physics in 2004, 24.7% in geography in 2004, and 21.3% in English in 2004. The difference between Table 11 and Table 13 is striking with mathematics appearing very different to the others at A grade.

Reviewing these figures, it is interesting to note the overall attrition in student numbers and the proportion of students studying mathematics over the period of 1999-2004 and also 2001-2004. At the same time the level of mathematics A level students, in terms of previous GCSE achievement, has slightly risen and the proportion of students achieving the highest grades in mathematics has soared. It is possible that good mathematicians continuing to take mathematics, and drop-out being seen at the lower end of the ability range, can explain this.

Evidence from later in the report discusses in much detail the apparently high level of demand of mathematics A level in comparison with other subjects. Much attrition, both during courses, and between AS and A level, is accounted for by students leaving because of the level of demand. It is notable that, for all the subjects looked at in this study, the biggest difference in the percentage of A grades awarded at AS and A level is in mathematics. This could indicate a substantial difference between the two cohorts. Looking at students who achieved AS, but continued to full A level in other subjects (those who took the qualification as their ‘fourth’ AS), mathematics students show the largest difference in average GCSE achievement, despite

both groups showing the highest average scores in their groups. AS mathematics students had an average of 6.3, A level mathematicians had an average of 6.7.

Male/Female participation

Table 14 – 2002 GCSE entries and A-C grades by gender

Subject name	Total entries	% girls	A-C Total	% girls A-C
English*	679175	49.6	401628	56.0
geography	241396	43.9	145202	46.6
mathematics	714829	50.2	361911	50.7
physics	46638	39.9	41225	39.7

The data in Table 14 shows the gender breakdown for GCSE entries in 2002 (in order to compare with the 2004 GCE figures, they are roughly the same cohort), and the A-C achievement by gender. The gender balances in English and mathematics are broadly equal for entries for boys and girls.

Table 15 – 2004 GCE entries and A-C grades by gender

Subject name	Total entries	% girls	Entry as % of 2002 GCSE entry (total table 14)
English*	80262	69.8	11.8%
geography	33751	45.3	14%
mathematics	56700	37.8	7.9%
physics	27759	22.3	59.5%

The data in Table 15 show the 2004 GCE entry breakdown and figures. They show that A level English has a female bias (almost 70%) and mathematics has around 62% of boys. This move toward a bias in favour of girls is more easily explained in English where more girls achieve at A-C than boys; however this is not the case in mathematics where achievement is equal at A-C.

The proportions of males and females taking A level and the AS were compared over time - from 1999 to 2004. In all cases for the comparison subjects, the proportions have remained steady over time. In both physics and mathematics there is a persistently, but slightly higher, proportion of females doing AS than A level, indicating proportionately higher drop-out by females after AS.

Looking in detail at gender and performance over time shows all students increasing at the top end, but females' performance in physics showing the most remarkable improvement where the percentage of females achieving A and B grades rose from 47.8% in 1999 to 58.3% in 2004. In the same period the percentage of males achieving A and B grades rose from 43.9% in 1999 to 48.2% in 2004 (see Appendix B for detail).

Table 15 is also interesting since it shows a rough measure of 'conversion' rate from GCSE to GCE. The only broadly comparable subjects in this table are English and mathematics, since most students will take these GCSEs and their entry levels are very high. English is far more successful at converting its GCSE students to GCE students, showing almost 12%, compared with around 8% for mathematics.

Cambridge Assessment Analysis of subject combinations

These data examine student subject combinations to see whether the combinations involving mathematics have changed over time, comparing legacy and Curriculum 2000, as well as looking at change during the implementation of Curriculum 2000.

Detailed tables showing the top combinations are shown at Appendix C, however for those subjects which include mathematics, and which have figures for each year, the numbers of students taking the combinations has been compared in Table 16.

Table 16 - Most common combinations of at least three subjects in 2001, 2002 and 2003

Combination				**2001**	**2002**	**2003**
biology	chemistry	mathematics		6462	3900	4007
chemistry	physics	mathematics		4713	2909	2623
physics	mathematics	computing		1477	1095	981
chemistry	physics	mathematics	further maths	1374	956	847
biology	chemistry	physics	maths	990	1048	925

Table 17 uses numbers in 2001 as a starting point (100%) and calculates the proportion of change in percentage terms.

Table 17 - Most common combinations of at least three subjects in 2001, 2002 and 2003 (%)

Combination				**2001 %**	**2002 %**	**2003 %**
biology	chemistry	maths		100	60.35	62
chemistry	physics	maths		100	61.7	55.7
physics	maths	computing		100	74.1	66.4
chemistry	physics	maths	further maths	100	69.6	61.6
biology	chemistry	physics	maths	100	105.9	93.4

In terms of actual numbers of students taking these combinations including mathematics, there have been substantial decreases. This is in the context of greater numbers of students overall taking A levels, because of increasing cohort sizes as well as any increase in proportions staying on. However, they are clearly taking more varied combinations. The total number of combinations in 2001 was 86,957 (studying at least three A levels, excluding general studies), with 8.45% being taken by just one candidate. By 2002 the number of combinations had risen to 100,533 with 6.45% of combinations being taken by one candidate.

The only combination that has stood up over time is the 4 A level combination of biology, chemistry, physics and mathematics, presumably because this is not prone to the 'dropping down' effect, since this will already have constituted a students' entire programme from the start of their AS studies. In the case of other combinations where three awards have been taken, the 'fourth' subject may have been continued at the expense of one of the others. The example in the list of chemistry, physics, mathematics and further mathematics is slightly different in that students taking mathematics and further mathematics will sometimes take mathematics in a single year and further mathematics in the subsequent year, allowing them to take a fifth, rather than sixth, award. This subject combination has also suffered since 2001.

Cambridge Assessment Analysis of patterns of assessment – GCE mathematics as a linear award

There has been some speculation that centres taking GCE mathematics as a linear award, that is sitting for all assessment at the end of the second year of the award, may experience greater success than those who take the qualification in the more usual way, that is by sitting some or all of the AS units in the first year and the remainder in the January and June of the second year. In order to gain an idea of the extent and impact of this practice a limited investigation of 2004 mathematics GCE data relating to this phenomenon was commissioned from one of the GCE mathematics awarding bodies (OCR/UCLES). It was necessary to have this work carried out by an awarding body since detailed information at unit level that includes information about the sequence of assessment is not generally available.

The full report on these data is available at Appendix D, and the following is a summary of key findings.

Table 18 - A level grade distributions for all candidates taking at least one unit in June 2004

Grade	No	%
A	4172	42.5
B	2081	21.2
C	1483	15.1
D	1053	10.7
E	674	6.9
U	344	3.5
	9805	100

Table 19 - A level grade distributions for all candidates taking six or more units, with six taken in June 2004

Grade	No	%
A	354	31.2
B	228	20.1
C	180	15.9
D	211	18.6
E	96	8.5
U	66	5.8
	1135	100

This list of candidates includes those taking resits, provided they also took six units in June 2004. They represent 11.6% of candidates in Table 18 .

Table 20 - A level grade distributions for all candidates taking all six units in June 2004

Grade	No	%
A	54	34.0
B	30	18.9
C	28	17.6
D	24	15.1
E	14	8.8
U	9	5.7
	159	100

This list represents the 'strict linear' students taking all assessment at the June 2004 opportunity. The numbers are extremely small, and represent only 1.6% of the candidates in Table 18.

Data were also analysed by the following centre types:

- Comprehensive schools (including modern)
- Selective/Independent Schools
- Colleges (including sixth-form colleges, further education colleges and tertiary colleges).

The proportion of 'strict linear' students by centre type was:

Comprehensive schools	0.6%
Colleges	0.8%
Selective/Independent	2.9%

The 'strict linear' approach is more common in independent and selective schools (although decidedly not popular), but a comparison of proportions of top grades achieved show that it does not appear to yield any benefit in terms of outcome. (See *Table 20.)* Although the numbers are small for the 'strict linear' group, the data indicate that there is no general advantage gained by sitting the award in a linear fashion. The proportion of A grades gained is significantly lower for those taking the strict linear approach (34%, compared to 42.5% of the total *OCR7840* cohort taking at least one unit in June 2004).

Table 21 - comparison of proportion of GCE mathematics A and B grades gained by Selective/Independent school pupils

Grade	**Strict linear group**	**All students**
A	34%	43%
B	19%	21%

It is interesting to get a sense of the scale of this phenomenon, as well as some idea of its utility as an approach to assessment.

Resits

Table 22 displays the number of candidates that took each unit (for example, for unit 2631 (P1), 3,052 candidates took it twice, 511 took it three times and 31 candidates took it four times).

Table 22 - Distribution of the number of times each of the 17 units was taken

Unit	**Times sat**					
	1	**2**	**3**	**4**	**5**	**6**
2631	6601	3052	511	31	0	0
2632	6258	3257	314	10	0	0
2633	9292	841	71	2	0	0
2634	1593	398	1	2	0	0
2635	1144	20	0	0	0	0
2636	1050	31	1	0	0	0
2637	5987	1833	253	6	0	0
2638	4426	576	48	2	0	0
2639	1106	66	1	0	0	0
2640	208	4	0	0	0	0
2641	7228	2044	306	17	1	1
2642	5404	617	49	2	0	0
2643	970	52	2	1	0	0
2644	132	0	1	0	0	0
2645	2837	439	64	3	0	0
2646	879	104	4	0	0	0
2647	93	2	0	0	0	0

This table is interesting, showing that several units have a very significant proportion of students retaking. Over half of students took unit 2632 (P2) on two occasions, and almost half took 2631 (P1) on two occasions. Of the other units, significant proportions of students took 2637(M1) (30.6%) and 2641(S1) (28.3%) on two occasions.

The large retake units are all AS units, and it is likely that they are retaken by a large number of candidates to improve grades and/or uniform mark scheme results for several reasons:

- they are the units that are taken in the first year of the course - so there is more opportunity for resitting
- they are the units that are taken in the first year of the course when the students' development is most limited - so there is more room for improvement
- they are the easier units - so that a really good result is more likely.

It has not been possible this year to look in detail at the average benefit to students in retaking mathematics units, that is the average increase in either grade or UMS (uniform mark scheme points). It is likely, because of the nature of mathematics, that the average benefit is greater than in many other subjects. Certainly, the scale of resitting is very large. It would also be useful to see the profile of retaking students' results to see whether the main focus of resitting is amongst the students achieving high grades, or those achieving lower grades. The high concentration of A grades at A level suggests that competition may be for high UMS scores and therefore A grade students are resitting frequently.

Large-scale questionnaire

The large-scale questionnaire that was completed in February 2005 by around 200 schools and colleges asked a number of questions about centres' mathematics students and teaching. A number of the analyses are illuminating on the issue of participation.

Centres were asked to provide details of their AS and A2 cohort sizes, and these figures were analysed to look at the relative sizes of each cohort. For all centres the total of A2 students was around 60% of the total of AS students. Within centre type this proportion varied, from 48% in FE colleges to 73% in Independent schools.

Respondents to the large-scale questionnaire were also asked to consider their A level cohorts over time (1999 and before, 2000, 2001, 2003 and 2004) and to consider the proportion of AS and A level mathematics students. In all cases the modal response was that the proportion was unchanged; there was no clear direction amongst the remaining centres. This is interesting in itself, since there is evidence from the national data that A level participation in mathematics is significantly down.

Case study centres

There was a similar finding in the case study schools data, where centres were asked to compare the number of students starting A level mathematics in 2003, 2000, and pre-2000 with 2004. In each period of comparison centres most frequently reported that levels of recruitment were ‘about the same’ as in 2004.

Case study centres were asked in particular about the impact of Curriculum 2000 on participation. Three of the centres reported that whilst recruitment increased, retention decreased: ‘the extra students were not very successful’. Some attributed the increased take-up to more students doing mathematics as a fourth (or fifth) AS and it was these students who were less able mathematicians and more likely to drop out.

The case study centres were also asked to provide details about their total Curriculum 2000 students (14- to 19-year-old students doing AS/A levels or VCEs), in order to establish a current baseline for the study.

AS mathematics students constituted 24% of Curriculum 2000 first-year students.
A2 mathematics students constituted 19% of Curriculum 2000 second-year students.

4.3 Drop-out in mathematics/non-continuation from AS to A level, including why

There are no reliable national data across all centre-types on drop-out during courses, rather than non-continuation from AS to full GCE. Some information on the pattern in FE and sixth-form colleges is available because records of students' programmes are required for the Individualised Learner Record (ILR). This collects information in the autumn of each academic year, as well as later in the year, so that drop-out from particular courses can be calculated.

However, for all other centre types – where most A level mathematicians are found – there is no comparable information. An additional problem in trying to identify drop-out is that the ILR does not consistently describe student intention in terms of programme. A student will usually register intent to complete an AS in one year, and then registers again the next year to complete the full A level award. Thus it is not possible to gauge whether they originally intended to complete the full award, or were just intending to complete the AS.

This project has tried to provide a feeling for the level of drop-out 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.

The large-scale questionnaire asked respondents a number of questions about drop-out and retention in AS and A level mathematics, to provide immediate information about the picture in centres. In addition, centres were asked if they were willing to be involved in a subsequent questionnaire in 2006. Over 90% of centres agreed to this and supplied contact details. It is hoped that this will provide a longitudinal picture of participation and retention.

Respondents 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). For all centres responding there was an overall drop of 12% in this period, which ranged from a rate of 16% in FE colleges to only 2% in Independent schools. This variation may have been owing to differences in entry requirements: 86% of FE colleges accepted students who had done intermediate tier GCSE compared with only 17% of Independent schools.

The data were also examined in terms of the spread of drop-out. Around a quarter of all centres reported no drop-out at all and a further 37% reported a rate of between 1–10%. Around 90% of centres reported drop-out of 25% or less.

The same routines were followed for A2 students, where the overall drop for all centres was 7% in the same period, with a range of 12% reported in state schools and 3% in sixth-form colleges.

At A2 a far higher proportion of centres reported no drop-out (67%), with over 80% showing a drop-out rate of 10% or less. A2 drop-out rates are, therefore, much lower than AS in the similar period.

The case study centres were also asked about initial drop out between September 2004 and December 2004, and reported a similar pattern of findings, AS centres reported a drop-out rate of 6%, A2 a rate of just 2%. The discrepancy in the magnitude can probably be explained by the additional period of time in the large-scale questionnaire, where respondents were asked for data in February rather than December.

Drop-out over time

The large-scale questionnaire asked centres for their impressions of drop-out in a similar period in the previous academic year (September -February 2003/4 compared with 2004/5).

For AS, the majority of centres (60%) reported no change, of the remaining 40% about twice as many reported lower drop-outs than higher.

For A2, a far larger majority (84%) reported no change, with the remaining 16% evenly split.

This question was repeated for the years 2002/3 and 2004/5.

For AS, the majority of centres (56%) reported no change, of the remaining 54% about four times as many reported lower drop-out this year compared with 2002-3 than higher.

For A2, a large majority (73%) reported no change; of the remainder the large majority (21% compared with 6%) reported lower drop-out rates this year than higher.

Retention AS to A2

Respondents to the large-scale questionnaire were asked a series of questions about their previous cohort of AS students (completing in 2004) and the numbers continuing to A2. The data were then analysed to represent the percentage of students completing AS who did not progress to A2. For all centres there were 33% of AS completers who did not progress to A2. At centre level this figure varied between 44% in FE colleges and 23% in Independent schools.

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 all centres, the reduction in student numbers between the proportion intending to progress and those actually progressing was 9% of the cohort who completed AS. In FE colleges the difference was 18% of the AS completing cohort, in Independent schools it was only 3%.

This, together with the over-course (pre-examination) drop-out, accounts for a substantial proportion of AS starters who fail to complete GCE mathematics. Further work will indicate the extent of drop-out over the first year, but the average of 12% reported by February is certain to have increased, possibly considerably, before June. Additional work is likely to be undertaken in 2005/6 using the ILR data from FE and sixth-form colleges to look at the extent of in-course attrition in AS. Although the data will not be representative of all centre types, it will allow for comparisons with other subjects to be made, which are not possible using the survey.

Centres were also asked about their practice in relation to recruiting students to GCE mathematics, in terms of their GCSE performance. Questions focused on whether centres had accepted students who took the GCSE mathematics intermediate tier, since there have been concerns expressed about its adequacy as preparation for GCE level.

Almost 60% of centres responding to the question did have some students who had taken the intermediate tier, this varied from 86% of FE colleges, to only 17% of Independent schools. In our sample, intermediate tier students accounted for 8% across all AS students, and 14% of AS students in centres where intermediate tier students were included. At centre type level this ranged from a quarter of students in FE to 10% in State Secondary schools.

Centres who did have intermediate tier students were then asked some questions about these students' performance in comparison with those taking the higher tier who got the same grade. In all cases intermediate tier students were considered more likely to drop-out than those who took the higher tier with the same grade (82% agreed with this statement, 15% felt they were no more likely, 3% felt they were less likely). They were also asked whether, for students with the same grade, they were more or less likely to continue to A2. Over 70% of centres felt intermediate tier students were less likely to continue to A2, and over a quarter thought there was no difference between the students. An intermediate-tier effect was also observed by some case study centres who said that these students were more likely to drop-out.

Centres responding to the large-scale questionnaire who did have intermediate tier students were asked whether they gave these students an opportunity to study the 'required elements' (for the GCE) that are only contained in the higher tier GCSE. The centres were quite evenly split on this, with 46% saying that they did not and 54% saying that they did.

A further question was asked to find out how students who had not done the higher tier material at GCSE were supported in terms of this content. Over 44% of centres reported that students were given some form of pre-preparation pack (worksheets, textbook etc), and 22% assumed only Intermediate level knowledge as the starting point for all GCE students. Around 15% provided workshops or additional support at GCE. Over 9% made no provision.

Reasons for drop-out and non-retention

The reasons for student drop-out 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 drop-out in their centres.

For AS students, the most frequently cited first response was that mathematics was harder than other subjects (49%), and the second most frequent response was that the students' knowledge was not at an appropriate level (26%). Taken together these account for 75% of all

responses. No other single response accounted for more than 7% of answers. This pattern was repeated at centre level.

For the second main reason, the top two responses from the previous question were reversed - the most frequently cited response in this case was the students' knowledge was not at an appropriate level (32%), the second that mathematics was harder than other subjects (29%). Taken together these account for 61% of all responses. Full details of all responses can be seen in Appendix E.

For A2 students it is worth noting that a far higher proportion (51%) of respondents did not respond to this question, twice as many as did not respond to the equivalent question about AS. This is probably accounted for by the far fewer students reported to drop A2 than AS.

Of those who did respond to this question, for the first reason 'mathematics being harder than other subjects' accounted for 44% of responses, the next most popular response was the student leaving the centre (11%).

Response rates to the second part of the question were even lower for the second reason. Of those responding, the student's programme being too full accounts for 24% and mathematics being harder than other subjects accounts for 22%. Student's knowledge not at an appropriate level accounts for 19%.

Students from case study centres who had dropped-out from their GCE mathematics courses were interviewed about their reasons for not continuing. The largest number of students said that they dropped-out at the end of the AS year. However, responses to when students dropped-out ranged from during the induction for AS to January in year 13. The majority of them dropped-out because they found the subject too hard and couldn't keep up, which is in line with the large-scale questionnaire findings. A small number of students thought that it took too much time away from their other subjects, and a similar number of students said that they didn't enjoy mathematics. Other reasons cited by a few students include that they would get better grades in other subjects; they didn't need it for university; they failed their AS; it was taught poorly, and they wanted more breadth.

AS mathematics students were asked about their plans to continue to A2. The majority of students were intending to continue to study mathematics at A2, including a couple of students who originally only intended to study mathematics at AS level. Some students who

intended to only study mathematics at AS were not going to continue to A2. Interestingly, a significant number of students were waiting to see what their AS results were like before making any final decisions.

Teaching staff at the case study centres were asked for their perception of the issue of drop-out both in the visit and telephone interviews. Across both interviews ‘difficulty’ was most frequently given as the reason for non-completion. In these cases, students had found the content of the A level too complex. In July, nearly all the centres said that students gave this as a reason for dropping mathematics. About a quarter explicitly stated that it is not simply because the A level is hard but because it is harder to get a high grade in than in other A levels. Case study centre students themselves generally said that mathematics is relatively difficult, with more to learn. Indeed, some centres referred to a ‘high workload’ for this ‘time-consuming’ A level.

On the whole, teachers had not observed a gender effect, with only three saying that boys are more likely to drop-out and one saying that girls are more likely to drop-out.

4.4 Student choice of mathematics/Reasons for not choosing mathematics

The case study centres were a rich source of information about why students chose to study mathematics. A large-scale survey carried out in December provided information for a high level report on GCE mathematics students' choices and motivations, whilst the interviews in February gave more opportunity for detailed discussions of their experience. As well as AS and A2 students, the interviews involved students who had dropped out of GCE mathematics, as well as students with good grades in GCSE mathematics who had chosen not to follow mathematics at GCE. In addition, the large-scale questionnaire 'other comments' section had some valuable insights in this area.

Motivation for choosing GCE mathematics

The students were asked about their main reason (or 'deciding factor') for choosing to study GCE mathematics. Of the 1,102 students responding to this question, almost one third (31%) cited 'enjoyment'. Of the remaining reasons given, 18% cited their need for mathematics for their career, and another 18% that they had coped at GCSE as key to their choice. Around 13% reported its being a 'useful qualification' as the most important reason, and 8% that it was a 'well respected' qualification. Details of all responses are shown at Appendix G.

An analysis by gender shows 40% of females rating enjoyment as most important, compared with 25% of males, whilst 22% of males felt career was key, compared with only 12% of females. Coping well accounted for 20% of males' responses, and 14% of females'. Other differences were not so marked. The high percentage of girls reporting enjoyment as key is important to note.

The responses were also analysed in terms of whether they were AS or A2 students. On the whole, the responses are similar. However, more A2 students (36%) said that enjoying mathematics was a deciding factor than AS students (28%). Conversely, the need for career was slightly higher for AS students (20%) than A2 students (15%).

The survey then asked the students about each deciding factor in turn, asking them to rate its significance in terms of whether it influenced their choice: 'a lot', 'a little', or 'not at all'.

Table 23 - For each factor the 'influenced a lot' ratings are as follows:

Factor	All students	Males	Females
I thought it would be a useful qualification to have	83%	86%	78%
I coped well with GCSE mathematics	76%	73%	80%
It fitted well with my other subject choices	54%	56%	51%
I enjoy mathematics	50%	45%	58%
I need mathematics for my future career	43%	48%	35%
I was better at mathematics than at other subject	43%	44%	42%
The teaching staff are good	40%	40%	39%
My parents encouraged me to study it	33%	33%	33%
The mathematics department's results are good	29%	31%	27%
My teachers encouraged me to study it	28%	27%	30%
My friends encouraged me to study it	5%	5%	5%
I wanted to do the same subject as my friends	2%	1%	2%

Again, the main discrepancy in scores appears to be around two themes, utility and comfort. Males score two factors around utility more highly than females: 'the usefulness of mathematics' is very influential to over 85% of males, and 78% of females, and 'needing mathematics for my future career' was stressed highly by 48% of males and 35% of females. This difference in balance is reversed for 'comfort' factors: 'coping with GCSE', where 73% of males rated it most highly, and 80% of females and 'I enjoy mathematics' rated most highly by 58% of girls and 45% of males.

Looking at the same issue from the students' AS or A2 status shows only one item where there is substantial difference, 'enjoying' mathematics was reported as influencing choice 'a lot' for 47% of AS students, but 55% of A2 students. This may indicate that those who enjoy mathematics tend to stay on to A2 study, and thus why the percentage reporting enjoyment is higher.

There was also analysis of the factors based on students' grade achievement at GCSE. Here 90 of the A* GCSE mathematics students said that coping well at GCSE had influenced them a lot in choosing GCE mathematics. This was the highest response in any grade for any of the factors. The proportions saying 'coping well' influenced them a lot was also highest for A*

students. Interestingly, the usefulness of the qualification was rated highly most frequently by B grade students, and needed for career most frequently by C grade students.

Students were also asked in the survey about what they intended to do when they completed their A level studies. Of the 1,165 students replying to this question the vast majority intended some form of HE progression, with only about 6% reporting that they intended to get a job and a further 5% reporting that they 'did not know'. The highest response was 'HE unspecified' (13%), followed by 9% for commerce-related subjects, 8% for engineering and 8% for medicine/dentistry and 6% wanting to study an arts and humanities subject. On completion of A level, 9% of the students explicitly stated that they would like to study mathematics.

In student interviews, for all A level mathematics students, the main reason for A level choice was their enjoyment of the subject closely followed by being good or confident within the subject. A large number of students had already decided on future career aims and therefore their subject choices reflected this, and a small number said that they chose subjects that complemented and supported each other with an overlap of content. A few students said that they consciously chose subjects that gave variety and therefore would not restrict future options.

A number of students said they chose options such as psychology and communication studies as they had not had the opportunity to study these areas before and liked the idea of combining something new with more familiar subjects.

A small but significant number of students said that some of their choices were based on the perceived level of demand required for the subject. Many of the students made choices based on their GCSE results with one student saying that she considered what employers would like to see on a CV. A small number of students mentioned that they had to change their original A level choices due to timetable clashes.

Students who had continued to A2 were asked about their reasons for choosing mathematics, and while enjoying mathematics was one of the most frequently cited reasons for continuing to study it at A2, enjoyment was intrinsically coupled with whether students were good at the subject and found it easy. Of this group of students the majority thought they were either good or quite good at mathematics, with a small minority believing that they were only good at some aspects or not good at all.

A large number of the A2 students said that mathematics was a requirement for entry into their chosen university course and a smaller number of students thought that it generally complemented their other A2 choices and would look good on their UCAS application. Some students thought that mathematics A level would look good on their CV and impress future employers.

Why students chose not to study mathematics at A level

Students who had achieved well at 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 school's 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 e.g. 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.

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 like to have had more detail about the course content at AS level when given information about studying A level subjects.

Many students mentioned that they would need financial incentives to study mathematics. One student would have studied mathematics if she were given ‘quite a lot of chocolate’.

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, with one respondent referring to the coursework as a ‘millstone’.

Prior awareness and student choice

All students were asked specifically about the sources of their prior knowledge of A level mathematics that informed their choice. The majority of students received their knowledge of A level mathematics, prior to opting to take the subject, from older students who generally warned them how hard the subject is. While some older students stressed how much work was involved and what a big jump there is between GCSE and A level mathematics, others stressed the usefulness of the subject and how it was difficult but manageable. Friends and relatives was the next most cited source of prior awareness; again the focus tended to be on how difficult A level mathematics is. The advice given by teachers can be characterised as cautious encouragement, explaining the difficulty but also emphasising the benefits. The press was also a source of prior awareness for some students: students said that they had read that A level mathematics is getting easier and that there has been a fall in uptake. Another group of students 'had heard' that mathematics was difficult, but didn't state where they had heard it.

One of the most frequent comments in the 'further comments' section of the large-scale questionnaire was about the perception that A level mathematics is more difficult and demanding than other subjects. Some respondents said that students were opting for other subjects that they thought would be easier and would take up less of their time. This was consequently having a negative impact on take-up of A level mathematics. A few respondents suggested that this could be addressed by amending the UCAS tariff for the A level.

Recruitment

In student interviews teacher encouragement was the most recurrent issue in terms of recruitment. The most common point made was that teachers only encouraged those they thought capable of undertaking A level mathematics, particularly those in the highest mathematics sets. A smaller group of students said that teachers were honest and told them the grade requirements, and warned them that it would be difficult. Other advice came from taster sessions, induction evenings and information booklets. There was some active persuasion by teachers for students to continue with mathematics, although this persuasion was not always successful. Some students said they experienced no form of selling, and that they made their own choice. A small number of students were persuaded by their parents to pursue mathematics, and a Connexions officer encouraged one student.

The students' reports on recruitment were corroborated by staff interview data where over half the centres reported encouraging their students to take A level mathematics during GCSE mathematics lessons, with almost all saying they encourage their top sets only. Nine centres

use choices evenings or open days/evenings to tell students about the subject. Six centres give advice to parents about the suitability of the students. The three colleges in the sample said that they liaise with feeder schools to tell them about their A level mathematics offers. One centre offers GCSE statistics and this gives a good idea of what to expect from S1. One said that their year 13s visit year 11 lessons to tell them about their experiences of the subject at A level. Two centres said they emphasised the usefulness of the subject to future careers.

In terms of professed entry requirements to A level mathematics, all the case study centres require their students to attain a specific grade in GCSE mathematics. In most cases (10 centres) a grade B or better is usually required. Slightly more centres than not do accept GCSE intermediate-tier students. All the centres have criteria for progression from AS to A2 (with the exception of one centre offering a linear course). Half the centres (nine) usually required an E grade or better. In several centres (six), students decided whether or not to progress to A2.

Comparison with other subjects

GCE mathematics students were asked to reflect on the relative difficulty of mathematics compared with their other subjects. Generally, students thought that mathematics was more difficult than other subjects. Many students they thought there was a lot more to learn and that the subject required more effort, however some students thought that there was less to learn.

Subjects cited as easier than mathematics (in order of frequency, highest first) were: biology; physics; psychology; English; geography; chemistry; art; DT; history; leisure and recreation; PE; ICT.

Subjects cited as harder than mathematics (in order of frequency, highest first) were: physics, chemistry, biology, German, languages, history, PE.

Subjects cited as less demanding in terms of time and effort (in order of frequency, highest first) were: physics, IT, PE.

Subjects cited as more demanding in terms of time and effort (in order of frequency, highest first) were: physics, chemistry, biology, business studies, DT, law, history.

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.

A2 students - There were no obvious differences between those who were doing the new specification at A2 and those continuing on the previous specification. Students tended to refer to their transition from GCSE to the old AS rather than hypothesising on how their transition would have gone if they'd done the new specification in their first year of A level. However, one group of second years doing the new specification said that 'C1 and C2 flowed better from the GCSE course'; they liked the non-calculator unit because it was 'a continuation of the GCSE non-calculator work' and preferred the split between C1 and C2 of algebra and proofs and then calculating and solving.

Many A2 students groups thought that further content should be added to GCSE mathematics to better prepare them for the 'jump' to A level that many had been warned of and experienced. Students suggested topics for which more should be included at GCSE. Algebra and trigonometry were most frequently mentioned, followed by differentiation and statistics. A few students thought that there was no time to fit any more content into GCSE.

Many of the A2 students enjoyed mathematics at GCSE – often referring to teaching methods – and many found it to be easy – quite a world away from mathematics at A level. A few students had not enjoyed mathematics. Time and again, students saw the difference between mathematics at GCSE and at A level as being a 'big jump' or a 'big leap'.

Some students were positive about coursework because it was easier to do well in than exams. Others did not enjoy it and found that it did not always relate to GCSE content.

AS students - Many AS students enjoyed mathematics at GCSE, like A2 students, often referring to their teachers. There was a little more variation within student groups at AS, with some students saying they had not enjoyed mathematics at GCSE. In some cases it had not given these students enough challenge, others said there had been too much repetition but some had felt it was rushed.

In comparison with A2 and those students who had dropped GCE mathematics, there was little mention of a 'big jump' from GCSE. Only two groupings made a reference to such a gap. However, many AS students felt that more should be added to GCSE to prepare them better

for A level. Like A2 students, they wanted more trigonometry and algebra and surds was also mentioned. Again, differentiation was mentioned, and this time probability too. These students were asking for content to be moved from A level to GCSE and two groups mentioned C1 by name. However, several other AS student groups said no further topics should be added to GCSE.

Students who dropped out of GCE mathematics - Some students who had dropped mathematics at A level said there were no topics that they did not cover sufficiently well at GCSE, however, some student groups also said that there was not enough time for more to be taught at GCSE or that it was hard enough already, which may account for the omission.

Many of the students felt that it had been a very big jump from GCSE to A level, and suggested topics that should be taught more at GCSE that may make the transition easier. As in AS and A2 groups, these students suggested more algebra and trigonometry be added to GCSE. Like A2 students they also suggested statistics. One group of students thought that 'GCSE was easier than it should have been'.

Most students who dropped GCE mathematics said they had enjoyed the subject at GCSE and only a few said they did not. Enjoyment seemed to be strongly linked to teaching (as in AS and A2 groupings). One group had not enjoyed GCSE because they had been 'poorly taught', the teaching focussed on how to 'pass the exam' and they could not see the worth of the coursework.

When asked specifically about the difference between GCSE and A level, most did refer to a 'gap', 'jump' or 'step up' and sometimes they said it was 'big', 'massive' or 'huge'. A level was widely thought to be a lot harder.

Students who did not choose GCE mathematics - Many students had enjoyed GCSE mathematics but had chosen not to continue to A level. However, the majority had not enjoyed the subject and some had mixed views. As in the other student groupings, enjoyment was linked, but to a lesser extent, to teaching. In some cases, the students disliked mathematics and good teaching simply could not make up for the content of the subject. A lack of enjoyment was often linked to difficulty and the need to invest a disproportionate amount of time in the subject (given that it was still worth only one grade).

Many students did not want to continue with mathematics because they did not enjoy it and many had found GCSE hard enough. Some said that they didn't have the confidence in the subject, in some cases despite doing well at GCSE. Some said that they had not been encouraged to take it at A level or that it did not fit with their other choices. A couple of students thought that physics was more practical and therefore more interesting.

Whether or not they enjoyed and coped with the subject, there was a strong message from the students that they could not see how mathematics could be used in later life or said that the subject was not useful at all, or would not help them in their future university or employment careers. It is unsurprising then, that when many had been told that mathematics would be harder than other subjects or had seen the low grades achieved by some in older cohorts, they decided it was not worth spending extra effort on GCE mathematics.

A level mathematics students' perceptions of subject discontinuity between GCSE and A level

A level mathematics students were asked to discuss the subject areas where they felt that there was discontinuity between GCSE and GCE mathematics. Students highlighted gaps between GCSE and AS in the following topic areas: algebra, calculus, differentiation, logarithms, mechanics, statistics and trigonometry.

Many students thought that the level of algebra should be more challenging at GCSE in order to stretch students more and to help bridge the gap between GCSE and A level. A few thought that it would be useful to include some basic calculus at GCSE, although some students thought that calculus should not be included at GCSE as it is "supposed to be accessible to all students". Other students felt that it would have been beneficial to them on their AS courses if they had covered calculus at GCSE, as they would have had an introduction to the topic rather than starting it fresh. Slightly more students stated that they felt it would be sensible to include some basic differentiation at GCSE as an introduction to the topic. One group mentioned that their GCSE coursework investigation involved maximum and minimum values and with hindsight they thought that it is "silly doing that without learning about differentiation". A small but significant number of students mentioned that a brief introduction to logarithms should be included at GCSE, with one group thinking that this would make GCSE a bit harder, and another group wanted to see the inclusion of logarithms so that students can then see how they fit into AS.

Some students thought that as mechanics is a completely new topic at A level, its inclusion at a basic level at GCSE would be useful. Some students particularly mentioned the inclusion of work on equations of motion and forces. Another popular area mentioned by many students, was a more in-depth focus on statistics at GCSE level. One group thought that the technique for teaching statistics could change to show more methods of analysing data so that the jump to AS would not be so great. Another group felt that they needed to do more work on spreadsheets and graphs at GCSE. The greatest numbers of students mentioned the need for more trigonometry to be included at GCSE, with trigonometry graphs specifically being mentioned.

Other areas highlighted by students included radians, binomial distribution and long division. One group mentioned that the gap could be reduced by splitting GCSE into areas of Pure, Statistics and Mechanics so that it follows the AS structure. Another group thought that students need to be taught how to set out methods and answers logically at GCSE level, and another group suggested a bridging course at the end of GCSE to give a simple introduction to A level topics.

A large number of students could not think of any topics that they did not sufficiently cover at GCSE. One group mentioned that GCSE was hard enough without the need to add any more topics to it.

Teaching staff

All case study centre GCE mathematics teaching staff are described as subject-specialists, and there is an average of 6 teachers per centre. The gender balance is slightly in favour of females who make up 56% of teaching staff. The bulk of teachers are aged between 31 and 59, the modal age group is 41 to 45 years.

A large majority of case study centre students thought that they had good teachers. Some students described their teachers as very encouraging and supportive, some said their teachers were approachable and gave them time outside of lessons, others said that their teachers were good because they made sure that all students understood what had been covered in a lesson before moving on, and a few said that their relationship of mutual respect made for good teaching.

There were some criticisms expressed, usually where one teacher doesn't measure up to another; reasons given included that they are inexperienced, not approachable, difficult to understand, and their teaching is rushed.

Most students reported having two teachers, some had three, particularly those studying further mathematics, a few had four, and a few had one.

4.5 Preventing drop-out

Both the large-scale questionnaire and the case study centre interviews were used to try and examine how centres tackle the issue of retaining students from AS to A2 and preventing drop-out from GCE generally.

The large-scale questionnaire asked centres whether they employed any strategies to support student retention. Overall they were evenly split between those who did and those who did not. There were, however, large centre type differences, with almost 80% of FE colleges employing strategies aimed at improving retention, compared with only 10% of sixth-form colleges and a quarter of Independent schools. Half of state Secondary schools reported employing strategies aimed at improving retention.

Centres were asked to describe the strategies they used, and to rate how successful they were (very successful, quite successful, unsuccessful, too early to tell). Increased teaching time, described as successful or very successful, was easily the most frequently cited, and accounted for almost a quarter of all strategies described. Un-timetabled extra tuition time, as a successful strategy, accounted for a further 14% of the total. No other strategy accounted for more than 10% of the responses, and there was no unsuccessful strategy that received more than 4% of the total responses.

The same issue discussed with case study centre students raised getting help from teachers outside of the lesson as the most frequent strategy employed. Many students stressed how approachable their teachers were, and that they could seek help either at lunchtime, after school, or in their teacher's free periods. Some students thought that this was very helpful. Other sources of support included extra revision lessons or support classes for those who were struggling.

There was some criticisms expressed by a small number of students, particularly that they didn't get enough help with problems in the class as there was often no time to go over things. A few students complained that their teachers were unavailable outside of lesson time. This is interesting in light of the large-scale questionnaire findings, which report additional teaching time as the most frequently successful strategy.

A small number of students mentioned mathematics revision websites as a source of support, and students helping each other.

Students who had dropped-out gave a range of different responses to the question of how their drop-out could have been prevented. Some students said that nothing could have been done to prevent them dropping-out. Another group of students thought that their teachers could have been more supportive, while another group said if they had got a higher grade at AS they might have gone on the A2. A few students said that had there been less content in the syllabus they might have continued, and a few thought that having a different teacher might have helped. A few students thought that if the subject was more relevant they might not have dropped-out, and another couple said that if their university course had required it then they would have continued.

Most case study centre staff interviewed reported that they offer additional lessons, often for revision, outside of timetabled time and most said they encourage students to approach staff outside of lessons if they need help, corroborating the students' views described above. In terms of formal policies, the most common policy cited for increasing retention was 'no dropping permitted until the end of AS', in addition selection strategies and cohort characteristics were cited as key to retention by a few centres.

Staff also reported that – outside of school policy – students used external resources for learning and revision, that they work with parents, they set up popular lessons from university students, or workshops instead of some lessons.

4.6 Reactions to new specifications

The large-scale questionnaire, distributed in February 2005 asked about the prevalence of use of the new A2 in centres (centres were able to choose whether or not to switch over to the new award half way through). There was an even split between those who chose to switch and those who remained with the legacy award. Of the case study centres, 10 offered the new A2 to some or all of their students and 7 centres offered only the old A2 to their students.

At the outset it is worth mentioning a clear dichotomy in the findings across all data sources. The findings are 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 evidence of unacceptable 'dumbing down' in A level mathematics. The split is not even; there appears to be more support for the reduction in content than antipathy, but it is probably linked to centre type, and particularly to whether or not the centre has a selective policy.

Increase in core content, reduction of application content

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 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. (Detailed analyses are included at Appendix E)

In the first significant difference group, of 174 total responses, 121 (70%) were positive. Seventy-three (60%) of these positive comments related to the reduction in content and subsequent easing of time constraints. Of the negative comments, the reduction in amount of application and increased emphasis on pure content accounted for 29 comments out of 40 (73%), or 17% of the total comments. Negative comments in total accounted for 23% of all comments.

In the second significant difference group, of 167 total responses, 80 (48%) were positive. Thirty-five (44%) of these positive comments related to the reduction in content and

subsequent easing of time constraints. Of the negative comments, the reduction in amount of application and increased emphasis on pure content accounted for 33 comments out of 65 (51%), or 20% of the total comments. Negative comments in total accounted for 39% of all comments.

It is noticeable that the first comments were generally more positive, 70%, and this was less clear-cut in the second comments, where 48% were positive.

In terms of centre type, the most positive of all comments were from FE, with relatively few negative comments, the most divided centres were Independent schools and sixth-form colleges.

The Tables below show, for the main responses, the actual numbers of responses across all types of response. The information shows very clearly where there were similarities and differences in attitude in response to different issues.

In terms of issues raised, the main focus is clearly on the reduction of content in the new specifications.

Table 24 - All centres

Reason	**Negative**	**Neither**	**Positive**	***Total***
Less content/more time to teach/easier/better pace	6	7	73	**86**
Reduced application/ more pure/greater emphasis on pure	29	4	13	**46**
Better for weaker students/better link to GCSE/more accessible	0	0	18	**18**
Comment on coherence of qualification or its structure	1	0	7	**8**

Second significant difference

Table 25 - All centres

Reason	Negative	Neither	Positive	*Total*
Reduced application/more pure/greater emphasis on pure	33	9	9	**51**
Less content/more time to teach/easier/better pace	10	4	35	**49**
Better for weaker students/better link to GCSE/more accessible	2	1	15	**18**
Comment on coherence of qualification or its structure	5	2	9	**16**
Non calculator paper	3	6	1	**10**

Main impacts of the new specifications on teaching

The subsequent question in the large-scale questionnaire asked teaching staff to identify the two main impacts of the new specifications on teaching. Again, this was an open response question that was coded and analysed after completion.

For both 'impact' questions, the most popular response was the increase in the amount of time available as a result of the changes. This accounted for about one third of all the responses to these questions. The second most popular response, about the increase in planning, change and rewriting, involved account for about 9% of all responses.

Reduction in content

The large-scale questionnaire asked about this change in terms of two separate impacts.

a. *Does the reduction in content give more time for students to acquire knowledge and understanding of the compulsory material?*
   The response to this question was overwhelmingly positive, with 90% agreeing that the new specification gave more time for students to acquire knowledge and understanding of the compulsory material. The range of agreement was from 93% of Independent schools to 71% in sixth-form colleges.

b. *Does the reduction in content help students to learn the compulsory material more thoroughly?*
   Again, the response was overwhelmingly positive, with 79% agreeing that it does help students learn the compulsory material more thoroughly. The range this time was from 83% in Independent schools to 67% in sixth-form colleges.

There was a subsequent opportunity in this question for staff to note down the other effects of this change that they had noticed or anticipated. This was a free response that was subsequently coded. Interestingly the most frequently cited effect was the reduction in application content that was seen as negative (26 responses of 88 in total, 30%). The second most common response was that standards of mathematics achievement would go down, and the third that this was a loss of an optional unit for able students. These first three comments accounted for almost half of all comments, and could be banded together as a single effect.

No other single issue accounted for more than five comments.

Case study centres interviewed on this issue were fairly evenly split between those centres who were for, against, or gave a mixed reaction to the reduced number of application units, both on the centre visits in February and during telephone interviews in July.

Those who were positive about the reduction in content said that it was 'better for students, especially those struggling', 'There is more time to complete the AS in one year', 'The reduction in application units should attract more students', 'pupils have a better chance', or 'it is easier to get through the work'. ‘Extra time’ was welcomed and ‘better balance’.

Those who gave a mixed response welcomed the fact that the A level is now more 'accessible' but expressed reservations about the reduced amount of application, the emphasis on pure, or ability of students to cope with mathematics at university, or the impact on the economy. Two centres said they were still short on time. The positive comments in these mixed responses included: ‘the course is now more manageable’, ‘pure gets the attention it deserves’, ‘AS can be completed in one year’, and’ it suits students who want to study only one AS application unit’ (S1 for A level psychology was mentioned).

Those who were not content with the changes (though sometimes recognising benefits) spoke of lower standards, less depth in applied mathematics and weaker foundations for university mathematics and the advanced study of related disciplines. Some felt that the generally

reduced understanding of how pure mathematics could be used in the ‘real world’ makes the content less relevant to students and has a negative impact on their motivation and progression. Some pointed out that some subjects (biology, geography and especially physics) rely on mathematics for skills in mechanics or statistics that are now less likely to be taught. Some felt that the new A level suited the less able but ‘it has not taken into account the needs of the capable students who do not want to study at a snail's pace. The new specifications are no preparation for a mathematics degree'. A few were ‘shocked’ or ‘appalled’ by the loss of an application unit. It is worth noting, however, that a couple of centres did suggest that a more thorough knowledge of pure gained in single mathematics would benefit the universities.

In terms of getting through the work, one centre said that students were reaching the same level as before in pure but taking longer to get there, but some reported that the increased time for core mathematics had led or would lead to higher student recruitment and retention.

Evidence from the case study centre interviews with students suggested that whilst some students are pleased at not having to study a third application unit, others are concerned about this, particularly those studying engineering who need mechanics.

Manageability

Despite the split response on the reduction in application, case study centres generally appreciated the improved manageability and reduced time pressure that the reduction in application had afforded them. In February, several centres said they were able to spend more time ensuring students’ understanding, either when first teaching new topics or during revision sessions. Several centres had been able to take a more exploratory or thorough approach to the concepts they taught and some had found more time for practice and revision.

In July, several of the teachers said they were able to spend more time teaching, ‘revisiting’ and revising ‘topics’, as well as practising for exams. Apart from the pace of teaching, the new A level seemed to have had little impact on pedagogy.

In July, most of the teachers’ comments about students’ reactions were positive and based on the increased manageability of the course, a better pace to teaching, more time for support and the easier transition through C1: more confidence, success, enjoyment, easier, less pressure. Three centres picked out year 13 students for mention, saying they were coping

better, were happier, or were pleased with expected higher grades. Clearly some students were still finding the course hard going and C2 was picked out for mention by a few.

In February and July, teachers said they were now able to teach at a more appropriate pace, with positive implications for recruitment and retention.

AS student interviews from the case study centre visits in February have been reviewed focusing on the issue of manageability. Bearing in mind that the students were still only about half way through the AS at this stage, it is still interesting to look at their responses.

C1 was found to be manageable in all cases except one in which students were just ‘coping’. It was said to be similar to GCSE by several of the centres. A couple of groups found it ‘easy’ or ‘easier than expected’.

Six groups of students made positive comments about Decision mathematics: Decision was ‘enjoyed’ (2 centres), D1 was ‘interesting’, D1 was one of the ‘favourite units’. Two groups made negative comments about Decision: Decision was ‘frustrating’ (2 centres), D1 was ‘harder than expected…didn’t have enough time at the end of the paper which was different from the practice paper’. One group of students fits into both of these groupings, which was ‘enjoyed and frustrating’. Thus most comments about Decision were positive. This is different to the student analysis including A2 students, which found more balance between the negative and positive comments.

Comments about statistics were fairly well balanced between the positive and the negative, with four and three groups respectively. Students said it was ‘enjoyable’, ‘enjoyed’, easy and logical’, and ‘interesting’ and, other groups of students said it there was too much and it was ‘too rushed’, ‘difficult’, and there was ‘too much time just plugging data into formulae’.

This statistics response is similar to that for all AS/A2 students.

Differentiation was mentioned by some groups with most making positive statements: ‘enjoyed’ (2 centres), ‘going well’, ‘quite good’, and ‘going quite well’. One group was less positive, saying that it was ‘difficult and confusing’ because it was ‘completely new’.

A few students were pleased about not having to do three application units, however this was the opposite for another group of students, particularly for those studying engineering.

Background knowledge

Respondents to the large-scale questionnaire were asked whether the removal of the indications of 'background knowledge' in the new specifications had been helpful. Overall, two thirds of centres disagreed that this was a helpful move, a pattern generally followed in each centre type, with the exception of sixth-form centres where the split was 50:50.

Centres were asked to comment on their answers. Of those who did comment (123 in total), the most frequent comment (59 (48%)) was that they would prefer to have this information, typically because generally the more information that was available the better in terms of interpreting the level of demand. The second most frequent response (25 (20%)) was that they had no opinion on the matter, or that it made no difference.

Case study centres were less concerned about this change. During the February visits there were no negative comments about the change, they reported that they tended not to assume prior knowledge, and that it therefore did not have any impact on them. In the July visits five centres said it was helpful to have removed the requirement, seven said it had had no impact (in many cases they had not noticed or did not use the indications of background knowledge, and three said it was not.

Formulae

Respondents to the large-scale questionnaire were asked whether they felt the reduction in the overall number of formulae to be learned was 'positive', 'negative' or 'neither'. Around two thirds of all centres felt that this had been a positive move, with 22% feeling it was neither positive or negative. Independent schools were the most negative about this change, with 24% finding it negative, compared with 45% finding it positive. Sixth-form colleges were the most positive (74%).

Formulae list

Following the changes to the A level in 2004, the list of formulae supplied to students in examinations is now slightly longer and as a result there are fewer formulae that students are required to remember.

Teachers from the cases study centres generally felt that students should learn by heart all relevant formulae and the change would therefore not affect their students. There was a feeling that if students prepare properly for the exams then the formulae list is redundant. A

few teachers did feel that the exams should not be a ‘memory game’, so the change was positive.

Maturation policy – spiral curriculum

Respondents to the large-scale questionnaire were asked for their views on the following question: ‘In some parts of the new specification we have tried to encourage an approach of introducing a topic at AS level, with a more sophisticated treatment of the subject at A2. Is this approach likely to be successful for all students?’. The majority of centres (70%) felt that this approach was likely to be successful, in terms of centre type this pattern was generally repeated, although sixth-form colleges were evenly split on the question.

Centres were asked to comment on their negative responses to this question, these were coded subsequently. The most frequent response was that splitting up topics in this way was either too confusing or too trivial (15 responses (31%)); the second most frequent response was that able students would prefer to study the whole topic at once (9 responses (19%)).

When this was raised in the case study centre interviews, eight centres were supportive of a maturation policy (spiral curriculum). A couple of centres mentioned that they did not like the idea of splitting up sequences into C1 and C2. Four of the centres were unhappy at the idea of 'half teaching' a topic and reasons given related to interrupting the flow of teaching, teaching topics without showing their usefulness through application, the need to revisit related topics at a later date, and reduced coherency.

Four of the centres felt that the change might have the effect of lulling some of the students into a false sense of security, encouraging some unsuitable candidates to continue the subject to A2.

Five centres said they were already adopting this approach through their teaching and that the change to the qualification would therefore not make any difference to them. Several centres said they would adopt whichever approach they thought best suited their students and the topics at hand. A few said they would not wait to add complexity in the cases of able students and would teach broad topics across C1 and C2 (two centres) or give harder questions to further mathematics students (one centre).

Non-calculator unit

Large-scale questionnaire respondents were asked whether the inclusion of a unit to be taken without using a calculator was a positive or negative change. Almost 60% of centres felt that this was a positive change, with 24% feeling that it was neither positive nor negative. sixth-form colleges bucked the general opinion with 37% finding the change negative and 42% finding it neither positive nor negative.

Across the case study centres, many teachers were for and many teachers were against the non-calculator unit. Whether for it or against it, opinions were often expressed in strong terms. There was strong evidence of differences in teachers' opinions within some centres too.

While some teachers said they were 'happy' about it and one thought it 'fabulous', others thought it 'silly', 'ridiculous' or that there was 'no point'. Some felt that it was a continuation of skills learnt at GCSE and others thought that the coverage at GCSE was sufficient.

Some said that their students were managing without a calculator and learning more as a result (expressing answers in surds or fractions). Others said that it had been a 'shock' for their students or it had 'frightened' them or caused 'panic'.

Graphic calculators

Respondents to the large-scale questionnaire were asked whether the rule that students were allowed to use graphic calculators in all other units was a positive change. Overall 55% of centres thought this a positive move, with 33% finding it neither positive nor negative. The change was most positive with sixth-form colleges (95%).

Case study centres felt that the allowance of graphic calculators in all units but C1 has had little impact. Most centres do not provide or choose not to use graphic calculators and most students do not have their own.

Just five of the centres seemed to make much use or would like to use them if more of the students had graphic calculators. In some cases, teachers were more enthusiastic about computers than graphic calculators per se.

Transition

Responses from interviews with case study centre staff in both February and July indicate that the new qualification improved the transition from GCSE to A level mathematics in half or more of the case study centres. Centres attributed this to the reduction in overall content and the associated reduction in pace but most especially to the transition role of C1.

These three quotes are indicative of the wider response: 'In C1 a significant attempt has been made to bridge the gap between GCSE and AS. There is more time to reinforce the GCSE skills and to extend them further'. 'It is a good idea to cut down on the material covered in the first year because it was always difficult to get through P2. It also allows the pace to change from GCSE to A level. Students can change gear in this transition period'. 'AS mathematics is more accessible… not putting off students at an early stage'.

Almost all the centres felt that C1 provided an important period of progression from GCSE, with many seeing the unit as a 'transition unit' and a 'confidence booster' for the students. However, a few centres said there is still 'a gap' or 'leap' and one noted particular issues for intermediate tier students struggling with the demands of independent learning. On the other hand, two centres found the 'overlap' between GCSE and GCE to be unnecessary.

On the whole C1 was well-received by case study centres, although some felt C1 remained too difficult for some students and for others it did not provide enough challenge. A few of the centres said that 'there is not enough meat in C1', that 'C1 is not much harder than GCSE higher tier', or that 'C1 content is the standard of the old O level'. They argued that 'GCSE should be brought closer to A level and not the other way around' or that 'introductory topics could be expanded'.

This evidence from the staff is similar to that gathered from the students. The groups of students all said that C1 was manageable, except one group who said they were just 'coping'. It was said to be similar to GCSE by several of the groups of students. A couple of groups found it 'easy' or 'easier than expected'.

A few of the centres thought that the division of content between C1 and C2 'lacks coherency' or found that 'the placing of some of the topics is quite disjointed'. They argued that some of the topics that have been split should be taught together to prevent repetition that 'slows down the flow of teaching'. Topics highlighted were: differentiation, integration, maximum and minimum problems, arithmetic progressions, geometric progressions, polynomials and

remainder and factor theorem. However, a couple of centres praised the greater 'integration' between C1 and C2 or the more 'logical' ordering in the core.

In February and July, several centres said they would reduce the amount of time they spent on C1 next year, particularly in order to start C2 sooner. In some cases, centres said that C2 required more time than they had expected and in other cases it was felt that the C2 exam had been scheduled too early, putting unnecessary pressure on teachers and their students.

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%) entered students for all AS units in the first year and all A2 units in the second year, with 18% 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% said that it would not, and 30% 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 case study centres it was possible to establish that almost all centres intended to take all AS assessment in the first year and all A2 in the second year. There is one centre in the sample that follows a linear pattern of assessment, with all units taken at the end of the second year.

There are two strong patterns of assessment in case study centres: all AS units in June of the first year, followed by all A2 units in June of the second year (0303), and – more commonly – AS (C1) in January of the first year with the remaining two AS units taken in June of the first year, and then one A2 unit (C3) taken in January of the second year, with the remaining units taken in June of the second year (1212). Data are incomplete in terms of the exact model adopted by each centre, but at least four centres are using the first model and at least seven the second.

Seven of the centres had changed their entry pattern for 2004/5, at least three had changed from 0303 pattern to the 1212 pattern. Almost all centres indicated that they expected not to make a change in 2005/6.

The data seem to suggest that centres are finding completing the AS assessment in a single year more achievable now, and the case study data may indicate that there is a move to consider students ready for assessment in C1 by January of the first year. This will be revisited in next year's questionnaire and centre visits.

In addition to the general pattern of assessment, centres responding to the large-scale questionnaire were asked whether any students would be completing the full A level in a single year. Of the 184 centres responding to this question only 5% indicated that none of their students would complete in a single year. By far the largest response, at least 30% (and possibly up to 50%, due to insufficient clarity in the data), indicated that this would be the pattern for their further mathematics students.

Experience of assessment

Case study teaching staff were generally more positive about the examinations in February than they were in July. This was because by July the centres had experienced exams in applied units and these were generally less well thought of than the exams for the core units. However, in both interviews the C1, C2, C3 and C4 exams were thought 'fair' and in July about half the centres said the exams were 'fair', 'as expected', 'reflected the content of the specifications' or 'the specimen papers were similar to the exam'.

Several centres said that C1 was 'simple', 'straightforward' or 'easy'. Some felt it was too easy or 'trivial' and there were two unsolicited mentions of question 1: 'ridiculously easy'. C2 was in some cases 'tricky' and there were just a few cases of difficulty with C3 and C4.

Some found the level of complexity in the applied exams to be a shock. S1 and M1 and D1 were mentioned in this context.

In terms of the format of the examinations, in February, a little under a half of the respondents made some comment. Three centres commented on the increased exam durations, welcoming the extra time. However, two of these centres requested still more time to enable their students (in one case ESOL students) to read and think. Two centres felt that D1 was too long (this was also mentioned in July). Other selected comments about the format of the exams were made by individual centres: S1 shorter questions were welcomed, the section B questions were harder than expected, the C1 answer booklet had too much space for answers which unnerved some students.

Not all centres interviewed in February/March 2005 had entered students for examinations, although some centres had not entered students by this time. Four centres said their students found the assessments easy or OK or said they liked them or were happy about them. In one centre, a further mathematics student found C1 so easy he was 'insulted' by it.

Three centres reported that some of their students had found one of the assessments hard. In one case this was a general comment about less able students continuing to struggle as expected, in other it was Y12s finding C1 hard and in the other, the respondent said that students had 'found the C2 paper to be a giant step from C1'.

Two respondents said that assessments had been too long for their students, in one case D1 and in the other S1, with students finding it difficult to complete the paper.

Students' responses to questions about the assessment were divided between those students who compared mathematics to the other subjects that they were studying and those who looked at the different papers they had taken. It is difficult to analyse the responses of the students who compared mathematics to other subjects owing to the range of subjects being studied. There were those who were studying mathematics with other science subjects and found that mathematics fitted in with the structure of these subjects. Those studying art subjects with mathematics found it difficult to compare the nature of mathematics with essay based subjects. A significant number stated that mathematics is perceived to be less demanding and easier because it does not involve any coursework.

Students were more or less evenly split between finding the examinations easy and hard. A number found the examinations straightforward and easy because they had been well prepared through the use of past papers. A number of students said that the new award content was easier and that the time allowed in the examinations was more manageable. One group thought that the mechanics and statistics mock examinations were easier than the core examinations. Another group found that the M1 questions were easier than the textbook ones that they thought were ambiguous. Students liked the C1 exam due to the way the paper was set out, making it easier to read and that it did not contain as much information. A number of students mentioned that this examination was easier than they were expecting.

Of those students who found the examinations difficult, P2 is particularly thought to have contained ambiguous questions and that there was insufficient time with students stating that they would have liked to have had more reading time. Students also highlight M1 as an area

of difficulty, containing questions that students felt that they did not know how to approach because they had not done similar ones in class. Many felt that they needed more time for this paper, especially for drawing diagrams. A criticism about C1 was the dislike of having separate question and answer booklets with a preference for a combined booklet such as at GCSE.

A significant number of students stated that the examinations did not contain anything that they were not expecting and that they found the papers manageable.

Choice and applied units

Of the case study centres, nine 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 (6 centres). 2 centres offered only S1 and S2. No centres offered only M1 then M2.

There was a feeling in nine of the centres in both February and July that it is difficult, perhaps increasingly so, to offer students a choice of application units (notably mechanics *and* statistics). In some cases, this was attributed to a lack of staff or students' interest. In other cases it seemed to be a new issue for 2004/5, related to the new A level. Now that it is possible to gain the A level with 4 AS units (C1, C2 and two units from D1/M1/S1) and 2 A2 units (C3 and C4) some centres may have sought to maximise their results by not offering students any of the A2 application units. Indeed, this was easily the most common combination of units offered by the respondent centres. Some respondents' remarks clearly add weight to this interpretation: *'most students will choose 2 application units from M1, S1 and D1. Students who do not do 2 units from M1, S1 and D1 will be penalised. For example, good physics students may want to M1 and M2; as M2 is harder they may get a lower grade. Similarly some biology students may want to do S1 and S2'.*

It should be noted that this assumes the first units are easier than the second modules. However, it might in fact prove easier for students to make the logical progression from D1 to D2, M1 to M2 or S1 to S2.

Retention and the new specifications

Of the centres responding to questions about drop-out in 2004/5, only one said there were more students dropping than usual. Nine said there was the same amount of dropping as

usual and two said there was less dropping than usual. The small response means it is impossible to make firm inferences but retention generally seems similar to previous years. In 2004/5 slightly more AS and A2 mathematics students dropped out in case study centres during the first half of the year than during the second half of the year (AS mathematics saw a drop-out rate of 5% up to December and then of 4% up to July and A2 mathematics saw a drop-out rate of 2% up to December and then one of 1% to July). Students were more likely to drop-out from AS mathematics than they are from A2 mathematics (our sample schools had an overall drop-out rate of 9% at AS and of 3% for A2 mathematics).

In February, only a handful of case study centres thought the new A level might have a positive impact on retention by virtue of a more manageable amount of content, a better pace of teaching and learning, improved results and enhanced confidence. Several centres had said that their year 13s preferred the new qualification and their year 12s were more happy or struggling less than previous cohorts. However, only one respondent thought the new specification might have a negative impact on retention. This centre expected a higher rate of progression to A2 that would include students not cut out to cope with A2 topics who would then drop out.

By July, in contrast to the earlier survey, one half of the centres said that the new specifications were helping to reduce non-completion. Six attributed this to the qualification being ‘easier’ now, four said that the ‘better pace’ of the A level was a cause, and three cited transition, greater accessibility or the ‘overlap’ with GCSE as being responsible for the improvement.

In July, a handful of centres expected no impact but of these centres, three had little or no drop- out in 2004 or previous years and 1 had a linear system. Several students dropped mathematics at the fifth centre. In this case the respondent felt that students’ reactions to the course and exams had been the same as in previous years.

A little less than a half of the centres raised issues about retention. Some comments centred on the relative difficulty of mathematics - perceived or otherwise. Some centred on the large amount of content and time required. A couple of centres felt that the media and other agencies must stop promulgating the idea that mathematics is tough. Both suggested that the usefulness and applications of mathematics be emphasised. One felt that until mathematics was at the same level of demand as other subjects, students - in order to maximise their grades - would tend to choose other subjects. Another respondent suggested that ‘a general

mathematics A level for non-specialists and a second further mathematics option for those who were very able would help'.

Continuation to A2

Case study centres were asked about the numbers of AS students that were expected to continue to A2. Nearly half of the respondents sounded positive about the numbers continuing to A2. Most of these centres were expecting more continuation than last year (in nearly all cases attributable to the new specification's content and the improved transition from GCSE). Of the remainder they were equally divided between those who were not expecting an improvement to those who were unsure or did not respond.

Completion of A2 next year

When asked to speculate on the rate of A2 completion in 2005/6, 13 of the centres expected all/almost their A2 students to complete A2 next year. Two further centres responded by saying only that the situation had improved and one said fewer than half.

Perceptions about future recruitment to AS/A level mathematics

During the interview visits to case study centres in February, more than a half said they believed the number of students recruited to A level mathematics had or would increase as a result of the 2004 changes to the qualification. They felt that once awareness about the changes had filtered through to lower year groups, recruitment to the A level might increase: *'If students are handling the course this information may filter down to prospective students and encourage them to do it'.* In some cases such as this, there was no sense that staff would be actively involved informing year 11s of the implications of the changes.

Several (5) centres said that recruitment to do just AS mathematics had or would increase. The AS was now better suited to students who could cope with AS but not A2 and students looking for a 4th AS as a result of its more manageable content and easier completion within year 12.

A substantial minority (seven centres) expected recruitment to be unaffected by the changes to the qualification. Two centres said that A level mathematics will still be seen as difficult and certainly the student prior awareness focuses on the 'notorious difficulty' of A level mathematics. Other centres said that recruitment would be hampered by a lack of awareness

about the changes, new 'trendy subjects' being introduced, and the fact that results are not expected to increase.

In July, one centre reported that 2-tier GCSE mathematics had increased take-up but 2 pilot centres expected no impact on recruitment. A few centres suggested that an ongoing problem was that ‘mathematics is harder than other subjects’.

4.7 Further mathematics

The large-scale questionnaire asked a number of questions about further mathematics, in particular focusing on awareness of the changes to further mathematics which mean that all an AS in further mathematics can be made up entirely from AS mathematics units.

Almost three-quarters (73%) of centres responding to the questionnaire were already offering AS further mathematics in their centres, ranging from 46% of FE colleges to 90% of sixth-form colleges. Almost the same proportion of all centres offered further mathematics at A2 (71%), ranging from 42% of FE colleges to 94% of sixth-form colleges.

Respondents gave details of student numbers involved in further mathematics courses and this was analysed in terms of their AS and A2 cohorts of students.

The AS further mathematics cohort constituted 13% of the AS cohort in the centres offering both (although, note that AS further mathematics students will not always be drawn only from the current AS cohort).

The A2 further mathematics cohort constituted 17% of the A2 cohort (although, note that A2 further mathematics students will not always be drawn only from the current A2 cohort).

Although the A2 further mathematics cohort is a slightly higher proportion of the A2 mathematics cohort that the AS further mathematics cohort is of the AS mathematics cohort, it should be borne in mind that the AS mathematics cohort is substantially larger than the A2 mathematics cohort (see earlier section on participation).

Respondents to the large-scale questionnaire were asked about whether they were aware of the changes to further mathematics, and 85% responded that they were aware of them. When asked whether they considered that the change would be likely to encourage more students to take further mathematics there was an even split between centres who thought that it would and those who thought that it would not.

Centres responding to the large-scale questionnaire who did not currently offer further mathematics were asked whether they were more likely to offer the award in the future because of the changes. Almost 40% said that they would be more likely to offer it, 61% said they would not.

In addition, the large-scale questionnaire asked whether centres were aware of the government funded distance learning further mathematics project. A healthy majority (64%) was aware of the project, however only 28% of centres thought that any of their students would be likely to do it. When asked the reason for their answer, three-quarters of centres replied that further mathematics was already offered at their centre, of the remaining centres 7% felt their candidates were not suitable and 6% felt their candidates would want staff contact.

Case study centres were asked about further mathematics. Fourteen of them were offering it and 5 were not. In July several centres made positive comments about the new further mathematics specifications, noting that more students were taking the qualification and that it was providing an important challenge for students, and that students were finding it interesting/enjoyable.

Several centres stated that they were using A level further mathematics to address the ‘narrowing’ and ‘reduced depth’ in A level mathematics and to prepare students for mathematics degrees and advanced study of related disciplines. A couple of centres were concerned about whether it is challenging enough any more and one felt it was an issue that further mathematics ‘seems to be totally separate’ from A level.

4.8. Other

Two-tier mathematics GCSE

The large-scale questionnaire contained several questions about the two-tier mathematics GCSE pilot; only 10 centres responding were involved in the pilot. Of these, 64% had all of their GCSE mathematics students on the pilot course, whilst 36% did not have all of them on the pilot course.

Centres involved in the pilot were asked how well the pilot appeared to prepare students for GCE mathematics, compared to the three-tier model. Of the eight respondents to this question, half felt it prepared them better, three thought there was no change, and 1 felt it was a worse preparation than the three-tier model. Further detail is included in Appendix E.

5. Next stages

The 2005/6 phase of the project will include similar forms of data collection and analysis to this year, but these will be designed to build on the work carried out so far.

National data

The 2005/6 matched candidate data and JCQ data will add in the results from the 2005 examination series. In addition, we will add Media to the comparator studies, providing a 'new' subject to the list and a new perspective to the data.

In addition we will draw on the ILR data to look at the issue of within-course attrition in some detail. As described above, the ILR is limited in terms of centre-type, and also cannot help with detailed analysis of the conversion from AS to A level, but we can look at whether rates of attrition in mathematics AS and A level have altered for those centre types covered.

If possible we will undertake an examination of the benefits of unit resitting in mathematics compared with other subjects, and analyse which type of students are mainly involved.

Large-scale questionnaire

As mentioned above, over 90% of respondents to the large-scale questionnaire in 2005 provided contact details and expressed willingness to be involved in an annual survey. We will be updating information about student participation and retention, as well as asking for further reactions to the new specifications. We will test out some of the early messages from the case study centres in a wider arena, and hope to pick up key emerging messages to discuss in more detail at the Summer seminar.

We will use this valuable source of information to explore again the issue of intended and unintended attrition between AS and A level in mathematics.

Case study centres

The case studies will be asked to provide updated information about their AS and A level students in the Autumn term and there will be a questionnaire to AS and A level mathematics students, focusing on some of the issues identified in this year's work. Visits to centres and interviews will focus on staff and student reactions to the new specifications, and their views

about mathematics more generally. We will be matching national results data to our case study centres in order to look at rates of achievement.

We will be holding a seminar for staff and students in summer 2006 to discuss the new award and mathematics A level in more detail.

References

[1] ALLAN, FM (2005) *Why do students choose to study AS-level mathematics?* Unpublished dissertation for MSc in Computer-Enhanced Maths Education, Napier University, Edinburgh

[2] WILLIAMSON, A (2004) *Take-up of Mathematics beyond GCSE* unpublished study for City of York LEA

[3] SMITH, Professor A (2004) *Making Mathematics Count – the report of Professor Adrian Smith's Inquiry into Post-14 Mathematics Education*, DfES

[4] Roberts, Sir G (2002) *SET for Success – The Supply of People with Science, Technology, Engineering and Mathematics Skills*, Exchequer

[5] WILLIAMSON, A (2004) *Take-up of Mathematics beyond GCSE* unpublished study for City of York LEA

[6] ALLAN, FM (2005) *Why do students choose to study AS-level mathematics?* Unpublished dissertation for MSc in Computer-Enhanced Maths Education, Napier University, Edinburgh

