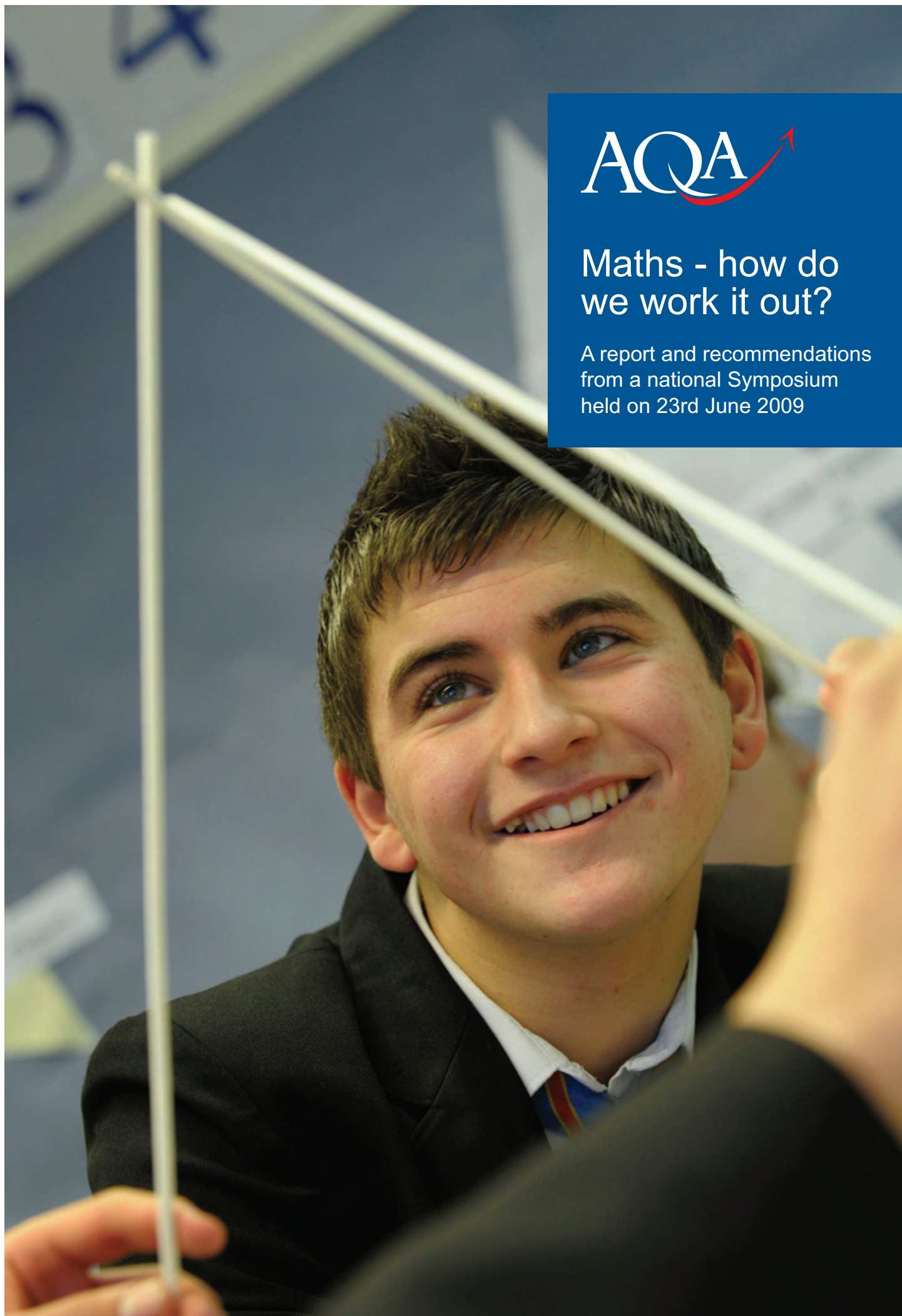




Maths - how do we work it out?

A report and recommendations from a national Symposium held on 23rd June 2009





In September 2010 new GCSE Mathematics specifications will bring radical changes to the way the subject is taught. The most significant developments are the introduction of Functional Mathematics, and a greater emphasis on problem solving and applying Mathematics. The aim is for the curriculum to have a breadth of approach which will appeal to and engage students of a wider range of abilities.

The Symposium participants were asked to consider the planned changes in relation to the recent past and to discuss and debate how long term benefits could result from the changes. The debate focused on concerns, aspirations and ideas surrounding the development and teaching of Mathematics, particularly at GCSE level, in the build up to the new Mathematics programmes of study.

Symposium participants

The event brought together a range of experts. The participants were:

Judith Judd, Chair, Editor at Large Times Education Supplement (in a personal capacity)

Nick Doran, Curriculum Adviser, QCA

Carol-Anne Moffatt, General Inspector Mathematics- Havering LA

Andrew Noyes, Associate Professor, University of Nottingham

Carol Plater, Principal Lecturer, University of Brighton

Jane Imrie, Deputy Director, NCETM

Jack Abramsky, Advisory Committee on Mathematical Education

Martin Dougherty, Royal Statistical Society

Jonathan Sharples, Manager of Partnerships,

Institute for Effective Education, University of York

John Neilson, Director, Research Base, Department for Business, Innovation and Skills

The issues participants addressed included:

- Considering how the new Programmes of Study and subject criteria meet the needs of students and influence the professional practice of teachers
- Discussing how the coming changes meet the needs of teachers and different groups of learners
- Reflecting on problems that may still need to be addressed and how these might be resolved to the benefit of teachers and students
- Tabling recommendations for changes to influence the teaching of Mathematics and contribute to the effective delivery of the new GCSE Mathematics.

As a result a number of recommendations were made. Some were based on a broad consensus amongst those taking part, others were put forward as real issues by individual contributors:

Summary of recommendations

- A National Mathematics Development Agency or Forum should be established to encourage collaboration across a range of organisations involved in Mathematics. There was a need for the different Mathematics specialist associations / organisations such as JMC, ACME and the NCETM to work together and to encourage all bodies in mathematics to work in a coordinated way, as well as policy makers
- The content of Continuing Professional Development should recognise teachers as key players with an approach that tackled the issue of specialists and non specialist teachers in Mathematics. CPD



was something that should be ‘done with’ teachers not ‘done to’ them. It was agreed that there should also be greater alignment between initial teacher education and CPD

- New and intelligent ways of assessing students should be developed which support approaches to Mathematics learning which were more engaging and brought alive the applications of Mathematics in different professions and emphasised its relevance to students’ lives in the wider worlds of higher education and work
- Real world Mathematics applications should be used in ways which engage a wider range of students and broaden the appeal of Mathematics as a subject for study
- Innovative pathways should be created for years 10 and 11 including new assessments, which are more challenging and not constrained by the Key Stage 4 programme of study
- The AEA in Mathematics should be retained to provide an important challenge for a significant group of students
- The false separation between Functional Skills and the curriculum should end
- Performance Tables should be scrapped to reduce the focus on ‘teaching to the test’.

There are a number of steps that AQA is taking to deliver the new Mathematics GCSE, based on two years of planning and pilots, which align with a number of the recommendations and these are included in the conclusions to this report on pages six and seven.

Mathematics Symposium discussion

Introduction

The Symposium participants took The Smith Report, *Making Mathematics Count* (2004) as

their starting point with reflections about recent history and curriculum changes and reforms which had been introduced over the last two decades.

Smith’s findings questioned whether the previous Mathematics GCSE had adequately prepared students for the worlds of work of further and higher education and whether it had best served the bottom 30 per cent of students and whether it had stretched the more able.

A new Mathematics curriculum at GCSE was designed to address some of the issues raised in the report and to tackle the issues of engagement and achievement across a range of abilities.

A number of questions were addressed and debated.

These included:

- How useful were the new Mathematics programmes of study in changing the Mathematics landscape in schools?
- Were there still underlying problems to be resolved which would ultimately make the changes more effective?
- What did teachers need to ensure they could deliver the changes effectively?
- How can the new Mathematics GCSE specification encourage methods of teaching and learning work that engage students across a range of abilities?
- What recommendations were needed to ensure that the changes at GCSE had a positive impact on schools and student achievement?

The context

There was a plethora of Mathematics organisations working towards similar objectives. There was more scope for collaboration, bringing this expertise together



to share ideas and experiences and to reflect on changes being developed and implemented.

The issues raised by the Smith Report were fundamental to informing the future reforms and changes of Mathematics qualifications and improving the situation for thousands of schools, teachers and students. Smith had felt the existing GCSE needed to be revised and improved and had made recommendations to this effect.

Some had been implemented and a new Mathematics GCSE was part of the future approach for schools.

However the new Mathematics GCSE did not resolve all the issues in Maths teaching and learning.

It was recognised that QCA and the awarding bodies were working hard to make the changes effective for teachers and for students particularly in relation to increasing the numbers engaged by the subject and the numbers continuing to A-level and beyond.

Evidence of this was the fact that a new GCSE was coming in for September 2010 teaching rather than September 2009 so that schools could be fully prepared for the changes. The double GCSE was only being piloted at this point.

One of the important issues was around planning the new curricula and new qualifications and seeing these as a whole. Implementation needed to draw on lessons learned from other changes. Functional Mathematics had been a classic example where the chronology had been wrong – starting with the standards and then addressing assessment. The three strands of curriculum, assessment and classroom practice (and therefore CPD) should be considered at the same time, as in the development of the Free-Standing Mathematics qualifications.

Teachers as key players and the role of Continuing Professional Development

Teachers needed to be key players in the content and direction of CPD.

Their early buy in and commitment to the effective implementation of change was critical in making the difference between success and failure. Continuous engagement was as important as CPD. This was also a relevant to the current generation of students involved in initial teacher education. There was an important synergy between CPD and ITE.

Teacher involvement, as partners rather than simply recipients, needed to be the starting point for the design of the content of high quality CPD. This was central to bringing about a culture change in the classroom, creating greater confidence in teachers who were not subject specialists, providing a rich and stimulating experience for students and contributing to the successful implementation of the new Mathematics GCSE.

Better systems were needed for the roll out of new qualifications.

Teachers frequently feel bombarded with change and new initiatives. They needed time to prepare sufficiently. First class materials, advice and support were part of the solution but continuous dialogue was vital.

Awarding bodies had a responsibility to give the right guidance and support at the right time if they were asking schools to work to deliver the new qualification.

Messages about the changes were being communicated early and well but in some schools there were particular barriers that were holding some back.

For example some Mathematics departments were not staffed with specialists and this picture was reflected across England in a wide mix of schools. This was one of the long



standing issues that needed to be addressed. Changes had come and gone but this was a constant factor and needed to be tackled through the right advice, support and training.

Many teachers still did not have the confidence to teach Mathematics in ways which engaged a wider spread of students. Subject knowledge was key to the success of any new qualifications and it needed to be secure. Secure subject knowledge enabled teachers to develop more engaging subject pedagogy.

Where it was variable it meant that some students had a more successful experience than others and this impacted on levels of achievement and a fall off from the study of Mathematics post GCSE.

The purpose was to train and support teachers for the future to ensure that by supporting teachers and developing more appropriate qualifications, learners will engage in Mathematics, be more successful and equipped to progress further and make a success of new qualifications.

Some issues were identified which could hinder the success of any new qualifications and which were part of the broader everyday national framework within which schools operated.

Performance Tables

Schools were frequently preoccupied by a focus on Performance Tables and for a lot of teachers, it was about their own Performance Review and the targets they had been set for the number of grade Cs they needed to achieve. In some respects this could have a detrimental effect on students who were sometimes encouraged to jump through hoops rather than be encouraged to think and apply Mathematics. Teaching to the test had produced a mixed experience for students.

The abolition of Performance Tables was seen as one way of resolving some of the current

problems. There was a need to do something different with Mathematics in schools and the mind set and framework of Performance Tables might mean less innovation on the part of teachers and their classroom practice.

There were additional pressures for National Challenge Schools with an intense focus on particular subjects and hitting targets.

Other issues included a long-standing debate between over-prescription and not giving teachers a detailed enough framework to teach the subject. Sometimes teachers had said there was too much prescription. At other times they disliked looser arrangements.

Prescription was not necessarily the main issue. It was about the capacity of teachers to enthuse about Mathematics, to talk about it in various contexts and to engage students of all abilities.

If everything was highly specified in the curriculum it put the focus on the content and not the Mathematics processes and removed the possibility of doing something different.

Some teachers lacked the confidence, subject knowledge and subject-specific pedagogical skills to take advantage of the opportunities that less specificity offered. Often teachers approached the requirements as a tick list which reduced the likelihood of delivering innovative teaching.

Assessment

Assessment was crucial but the form it currently took was problematic. Everything could not be tested in an end of year assessment. Assessment needed to be changed. How do you balance up the pressure to prepare students for the test and the teaching the curriculum?

The role and the relevance of Functional Skills in Mathematics was a related issue.

There was a problem of definition around



Functional Mathematics and there was still no agreement at a political level about this. Some organisations had worked to establish a shared view of Functional Skills in relation to Mathematics but there were still different positions and interpretations.

It was however not about basic numerical skills.

It was about enabling people to do Mathematics. There was a conflict with starting with the assessment and the body of knowledge, not how people were working.

There was a need for appropriate qualifications for those who dropped Mathematics at 16. This could be at a number of different levels, including the GCSE Use of Mathematics which was being piloted.

There was a wider thinking skills agenda. How can the assessment system be developed so it is possible to capture these quite difficult skills-based traits which can have a big impact on attainment?

Functional Mathematics was not a separate body of knowledge or skills, but should be an integral part of Mathematics.

Too often Mathematics teachers encouraged learning by rote.

Teaching and learning to the test placed constraints on the capacity of teachers to deliver a stimulating learning experience and made it far harder for some students to maintain high levels of motivation, engagement and achievement.

For example if young people needed to be prepared at school for the application of Mathematics in the work place then it could not be all achieved through a test in its current form.

It was the job of people teaching Mathematics to enable students to be functional in Mathematics.

In the new programmes of study a great deal of effort and time has been spent embedding functionality.

There were two big drivers - the change to two-tier and the changes to the Performance Tables.

Meeting the needs of different students

There was discussion about the two-tier approach to Mathematics GCSE.

It was one of the key Smith recommendations aimed at the bottom 30 per cent. It was quite a risky strategy to decide which students teachers enter for the Foundation or Higher stage to achieve grade C.

Sometimes measures that were intended to support the bottom 30 per cent may have a detrimental effect on students in the middle. It was important to ensure that the new changes did not have unintended consequences.

In an ideal world it would not matter what level teachers entered students for if they gave them access to the same curriculum.

Were there things that could be done to help teachers make the choices about which students to enter for which level?

A trend was developing where schools were entering students early in November. This raised the question of what happens to students who achieve a C grade at that point? Did they stop there or were they encouraged to build on what they had achieved?

There was a need to make the two-tier approach work better in the future.

Each subject had its own particular difficulties – Mathematics was not exempt from these.

In terms of the future twin Mathematics GCSEs it was intended that the majority of students should do both, but not all schools would behave in that way. Monitoring the pattern and statistics over time would identify trends and



practice across the full range of schools.

Increasing the number of students taking A-level Mathematics

Insufficient numbers of students currently progressed to A-level. This could sometimes be influenced by teachers not having sufficiently high expectations of all students. Were some students being written off too early?

The most able students needed to be given early opportunities to progress. How well were top 10 -20 per cent of students being served?

They needed to be challenged and some schools might be holding some of these students back from taking qualifications early.

There was increasing evidence of able students being accelerated through Mathematics early and dropping out post-16.

There was a fall away in numbers from Mathematics between GCSE and A-level.

Only 5,000 undergraduates (1 per cent of all undergraduates) studied for Mathematics degrees each year, yet 500,000 took Mathematics GCSE annually.

Not everyone wanted to do Mathematics degrees but a range of degrees in other subjects including the Sciences and Engineering required a high Mathematics capability. It was also an important objective to broaden the numbers doing Mathematics A-level even though some of these might not apply the A-level when they entered higher education.

Students needed to be enthused and stimulated around Mathematics if they were to stay the course and continue with Mathematics beyond GCSE.

AQA response

AQA welcomes debate on Mathematics education and is keen to address the concerns

and recommendations raised in this important report.

There are a number of steps that AQA is taking to deliver the new Mathematics GCSE based on two years planning and pilots, which align with a number of the recommendations.

Recommendation One: A National Mathematics Development Agency should be established to encourage collaboration across a range of organisations involved in Mathematics. There was a need for the different Mathematics specialist associations/ organisations to work together around the 2010 changes. It was both about collaboration and working at the same pace.

AQA response

AQA believes this would benefit schools and would be happy to facilitate a Mathematics Forum which could explore the possibility of setting up an umbrella body. The role of the Agency would need to be carefully defined to avoid simply adding to the range of organisations already engaged in Mathematics.

As a first step AQA is pleased to announce the launch of mathsbigchanges.com – a new website dedicated to the 2010 changes. AQA believes it is important that the entire Maths community are fully aware of the extent of the changes to GCSE Mathematics for 2010 and are able to benefit from the experiences of the Mathematics Curriculum Pathway pilots. AQA hopes to develop this site with the help of other organisations involved in Mathematics and is keen to encourage collaboration and sharing of information.

Recommendation Two: The content of Continuing Professional Development should always recognise teachers as key players with an approach that addressed the issue of specialists and non specialists in Mathematics. There should also be greater alignment between initial teacher education and CPD.



AQA response

AQA is developing specific CPD programmes building on the experience of the schools that took part in the new Mathematics GCSE pilots over the last two years.

AQA's Mathematics advisers include teachers from the pilot schools and they are actively engaged in offering advice and support to schools, through links with local authorities and visits to individual schools.

AQA agrees that teachers need to be involved from the beginning and has adopted this principle in developing the new specification and in providing the best possible support for the new specification.

Recommendation Three: Develop new and intelligent ways of assessing students which support approaches to Mathematics learning that were more engaging and brought alive the applications of Mathematics in different professions and emphasised its relevance to students' lives in the wider worlds of higher education and work.

AQA response

The new GCSE Mathematics criteria require a different approach to the assessment with some questions that emphasise problem solving skills and others which concentrate on selecting and applying skills and techniques.

AQA supports these changes of emphasis and has developed a different style of assessment which encourages students to be more independent in choosing methods and approaches and to be more confident in solving problems. It believes that the new approach at GCSE will engage a wider range of students, some of whom may previously have become disenchanted with the subject.

Recommendation Four: Ensure real world Mathematics applications were used in ways to engage a wider range of students.

AQA response

The new Mathematics Programme of Study has greater breadth and encourages students to problem solve and apply the Mathematics they have learnt to a wide range of real world applications. It is designed to widen the appeal of Mathematics to students across a range of abilities and to show how the subject has a wide ranging relevance. AQA believes that assessment at GCSE and in Functional Mathematics should reflect and support these aspirations whilst representing an appropriate challenge for the full range of learners at this level.

Recommendation Five: Develop innovative pathways for years 10 and 11, including new assessments, which are more challenging and not constrained by the Key Stage 4 programme of study.

Recommendation Six: End the false separation between Functional Skills and the Curriculum.

AQA response

Functional elements are written into GCSE and it is understood that most learners will be expected to also take a separate functional skills assessment. AQA wishes to support good teaching at Key Stage 4 which integrates functional skills fully whilst recognising that schools will want to prepare their students for the differing assessment approaches.

Recommendation Seven: Scrap Performance Tables.

AQA response

AQA sympathises with the pressure on teachers and schools due to Performance Tables and is committed to supporting them to maintain their targets while also providing worthwhile Mathematics education to students of all abilities.



Conclusions

AQA recognises that some students are leaving school without the Mathematical skills they need and that the current qualifications framework fails to meet the requirements of learners and that students' learning is based too much on their acquisition of methods, rules and facts (source: 2008 Ofsted report) 'learning by rote'.

The Symposium raised many important issues which are highly relevant to the future success of Mathematics GCSE. We agree with many of the concerns and share the aspiration to make Mathematics more engaging and appealing to a wider range of students.

Our vision is that the changes coming in September 2010 for Mathematics GCSE will mark a positive shift with an assessment that really supports the acquisition of Mathematical skills and understanding rather than simply concentrating on technical competence.

AQA believes that the changes to GCSE Mathematics will mean that:

- students will be more motivated to learn
- students will finish Key Stage 4 with the skills to progress to employment or Further Education
- more students will chose Mathematics for A-level
- students will enjoy Mathematics and teachers will enjoy teaching them
- there will be less focus on 'teaching to the test' and more emphasis on developing Mathematical understanding and its wider applications to the real world
- students will be able to apply the knowledge they acquire in Mathematics to other subjects.



NOTES:

