Response to Key Issues raised in the Post-14 Mathematics Inquiry

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Response to Post-14 Mathematics Inquiry

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SUMMARY of SUGGESTED ACTION POINTS IN THIS RESPONSE

1. Teachers of Mathematics

1.1 Supply/Recruitment and Retention

Encourage a higher quality intake of student teachers by restricting the number of training places on offer, whilst not penalising ITT institutions for *under*-recruitment.

Ensure that all prospective student teachers are first observed in a classroom situation before training places are offered.

1.2 Subject Knowledge

Secondary

Allow only mathematically qualified teachers to teach mathematics in secondary schools; for example, some mathematical study at degree level should be mandatory.

Primary

Restrict all mathematics teaching in primary schools to teachers who have achieved a Grade A at GCSE or an AS/A-level qualification.

Demand at least an AS-level in Pure Mathematics (and English) for entry into primary teacher training.

1.3 Training

University Practice Schools, or University Practice Departments in mathematics, should be established on a regional basis. These schools must exhibit effective and inspirational teaching of mathematics and be willing and able to play a key role in both pre-service and in-service provision and school-based research in their region.

1.4 Continuing Professional Development

Time should be protected for a school's mathematics department to work as a team, with the expert teacher(s) acting as the facilitator and with all staff participating in shared planning, delivery, observation, review and discussion on a regular basis.

1.5 Classroom Assistants

Each secondary mathematics department to have a dedicated support person or administrative assistant and each primary school to have a team of support staff.

2. National Expectations and International Comparisons

Abandon targets in national tests for particular levels (or grades) but encourage and support schools and teachers to raise their expectations of what their pupils can achieve.

Yearly tests should be developed and made available freely on-line to all, with a national representative database of results for comparison. Other countries should be encouraged to do the same, so that international comparisons can readily be made and regularly updated to show progress in participating countries.

Researchers should be encouraged to investigate mathematics teaching in other countries and to use their experiences to influence mathematics teaching in the UK.

3. Curriculum Content and Pathways

3.1 Key Stages 1 – 3

The national curriculum for mathematics and the 'Framework for Mathematics' should be revised to stress an integrated approach with meaningful applications stressed, particularly at Key Stage 3.

3.2 Key Stage 4

Mathematics should be an **optional** topic for study at Key Stage 4, and two distinct GCSEs in mathematics, namely

Practical Mathematics GCSE

Academic Mathematics GCSE

should be developed alongside the current

Statistics GCSE.

3.4 Post 16

A-level provision should consist of full A-level courses in

Mathematics (including applications)

Statistics

and AS-level courses in

Mechanics

Discrete Mathematics.

3.5 Progression/Interface

A collaborative research project should be undertaken by Higher Education and a group of secondary and feeder primary schools to consider the development of good practice in Key Stage 2 to Key Stage 3 transfer. The project should encompass the principles and practices set out by Michael Barber in his five 'bridges'. For instance, Key Stage 3 mathematics teachers would be given opportunities to teach in Key Stage 2 feeder primary schools for a regular and sustained period of time and vice versa.

3.6 Implications of ICT

Software should be developed and trialed as a national initiative so that all mathematics teachers have free access to the effective approaches that can support and enhance their teaching. (This could be an activity coordinated by the proposed 'Centre for Excellence in Mathematics Education'.)

4. Qualifications, Assessment and Testing

4.1 Key Stage 1 – 3

Develop freely available yearly national tests (for Years 1 - 9) that provide National Curriculum levels and diagnostic feedback.

Undertake detailed research into the impact of very early entry to GCSE mathematics examinations.

Develop resources to broaden the Key Stage 1-3 mathematics curriculum for gifted and talented pupils.

4.2 GCSE

All GCSE examinations in mathematics should use non-overlapping tiers, with candidates being able to enter any (or all) tiers and being awarded the highest grade obtained.

Coursework should be abandoned for GCSE Mathematics and extensively revised (in the way it is set, supervised and marked) for other mathematics GCSE courses.

Discontinue modular GCSE Mathematics for students of normal age.

4.3 GCE (AS, A-level, Further Mathematics, Advanced Extension Award)

Incorporate AS-level awards, each with one 3-hour examination, in

Mathematics
Statistics
Mechanics
Discrete Mathematics

with A-level awards gained from two further 3-hour examinations in

Mathematics
Statistics.

4.6 Awarding Bodies

Amalgamate examination boards into ONE national examination board, set up to provide an efficient and effective *service* for education.

Disband QCA forthwith.

5. Pedagogy

The Mathematics Education community, rather than the Government, should unite on guidelines for good practice in mathematics teaching and capacity building in schools and recognise and value diversity and innovation.

6. Teaching Resources

6.1 ICT

More research and development is needed to determine and disseminate useful software for enhancing the teaching of particular topics.

Research and development into diagnostic testing.

Development at Key Stage 3 of an integrated approach to lessons, based on using computers for one out of every three lessons.

Develop topical mathematical resources for pupils on a website, regularly revised and updated and with interesting statistics available or linked.

6.2 Textbooks

Textbook provision should be independent of examination boards and their examiners.

6.3 School Organisation

Protected time allocated for CPD.

Mathematics should be given priority in the use of ICT facilities for planned, integrated courses.

A dedicated mathematics administrative assistant to be provided to support the mathematics team so that the Head of Department is not engaged in low level maintenance tasks.

Mathematics should be timetabled, wherever possible, for early in the day.

7. HE Requirements/Transition Problems

7.1 Mathematics

Higher Education staff in mathematics should collaborate with and support A-level teachers.

7.2 Science and Engineering

HE institutions should undertake to provide ICT-based mathematical support, specific to the needs of the particular department.

8. Adult Numeracy

Comprehensive ICT support for adult numeracy should be developed from a foundation in mathematics, using relevant contexts and made freely available for use, in confidence if preferred, by adults.

9. Employer Requirements

The mathematics education community should build on the changing mathematical needs of employment, recognising that many young people will need *less* mathematical expertise in the future, but that a minority will need *more.*

10. National Strategies and Policy

10.1 National Numeracy Strategy (NNS)

The National Numeracy Strategy should re-focus its activities by concentrating on integrated mathematics courses.

Only mathematically confident and competent staff should be used to support schools, and the leading mathematics teachers scheme should be abandoned unless a system of quality control can be introduced.

10.2 Key Stage 3 Strategy

There should be no Key Stage 1, 2 and 3 strategies but a Year 1 to Year 11 integrated strategy for mathematics.

10.4 OFSTED

Replace OFSTED with full time, regionally based inspectors (who have an established track record of expertise in teaching and subject specialisation!).

Inspectors should be allowed to visit schools, without notice, at any time, and to go anywhere in the school.

Only when there is real cause for concern should action be taken (for example, Head of Department will be asked to formulate an action plan).

10.5 TTA

Integrate the role of the *TTA* within the DfES and ensure that different agencies and quangos are not competing for work.

12. Proposed 'National Centre for Excellence in Mathematics Education'

The National Centre for Excellence in Mathematics Education should build on the strengths of the many stakeholders in mathematics education, collaborating, delegating and coordinating rather than competing for the action and the funding.

National initiatives that would be suitable for the Centre to coordinate include

yearly national diagnostic tests for mathematics,
resources to use the applications area of mathematics in teaching,
Practical Mathematics GCSE,
quality software to support mathematics teachers,
a united approach to pedagogy,
integrated Key Stage 3 courses.

The proposed National Centre should disseminate mathematics activities through regional and local centres, ideally University Practice Departments in schools.

The National Centre should *freely* provide the results from activities proposed above and not be set up as a commercial operation.

Response to Post-14 Mathematics Inquiry

1. Teachers of Mathematics

1.1 Supply/Recruitment and Retention

The current crisis in both the recruitment and retention of mathematics teachers will inevitably worsen because of the impact of the significant drop in mathematics A-level candidates which will feed through the system over the next few years, together with the number of retirements over the next decade.

The current response of Government is to encourage (almost bribe) potential applicants into training or directly into schools, whilst Headteachers, unable to have classes without teachers, use significant inputs from

mathematically unqualified teachers

overseas teachers piloted into classrooms

supply cover,

most of which cause yet more damage to pupils' mathematical motivation and attainment. In fact, evidence from the Kassel Project (Burghes, 1999) points to the fact that it would be better for pupils to miss the lesson or be sent home rather than have supply cover!

Also, the Government's initiative to attract more people into the teaching profession, which in sheer numbers appears to be successful, might well be causing long-term damage. Much of the increase in numbers is due either to mature students who have failed at a particular job or career and are looking for another avenue of employment, or to younger students entering to pay off their student debt and not intending to stay more than a few years in the profession.

If we are to raise standards in mathematics what is needed are student teachers who have both a love and knowledge of mathematics and a desire and passion to teach. For this to happen we urgently need to raise the standard of entry with regard to subject knowledge and personal skills and qualities instead of accepting for teacher training any students who meet only the current minimum requirements. This applies for both primary and secondary mathematics teachers.

For mathematics teaching in primary schools, we need mathematically able teachers who fully understand the subject, to give children a good start (see section 1.2). This might, in the short term, even further reduce the recruitment figure but in the long term (and we need both short term and long term solutions) it is likely to result in more pupils and students being motivated to continue further study, inspired by their teachers. The situation now is that more and more classes are taught by inappropriate staff, resulting in increasing numbers of students opting out of mathematics.

To cope with even fewer (but inspirational) teachers in schools, please see our suggestions in sections 3, 4 and 6.

Suggestions

- Encourage a higher quality intake of student teachers by restricting the number of training places on offer, whilst not penalising ITT institutions for *under*-recruitment.
- Ensure that all prospective student teachers are first observed in a classroom situation before training places are offered.

1.2 Subject Knowledge

Secondary

The current situation in secondary schools, with much of Key Stage 3 mathematics teaching now taught by non-specialist teachers, is clearly not a sound policy. We feel strongly that providing conversion courses is not a viable alternative; it might provide some support for under-qualified teachers but it is unlikely to turn them into creative and charismatic teachers of mathematics! At best, it might slightly improve the current poor practice.

In fact, OFSTED suggests in its 'Secondary Mathematics Report, 2000/01', that there is a serious and continuing issue for mathematics for many schools in recruiting and retaining specialist teachers. The report states that in *one school in eight* there are insufficient teachers to match the demands of the curriculum. In addition, schools with a shortfall in their staffing often face daily problems in deploying staff. Un-qualified staff are often deployed to classes of younger pupils with the result that these pupils become disillusioned, make slow progress (often being taught incorrect concepts and wrong notation) and their attitude becomes affected over a long period. OFSTED also reports that mathematics teaching is only satisfactory or worse in one school in three.

Our preferred strategy is to attract only high calibre and mathematically well qualified students and to take other actions (see sections 3, 4 and 6) to alleviate the current problems.

Suggestion

- Allow only mathematically qualified teachers to teach mathematics in secondary schools; for example, some mathematical study at degree level should be mandatory.

Primary

One of the main differences between primary mathematics teaching in mathematically high performing countries in Europe and teaching here is that **all** their primary teachers have a mathematical qualification of at least A-level standard. OFSTED reports in 'The National Numeracy Strategy: the first three years 1999-2002' that it has been a priority for the Strategy to improve teachers' subject knowledge but also states that weaknesses remain.

If we are to make further progress in primary schools there has to be a focus on mathematics rather than numeracy, as teachers need to know and appreciate where the topics are heading and what is important (for example, correct notation, writing and speaking mathematics precisely and correctly, mathematical logic). This is dealt with in more detail in section 3 but as a way of improving the situation we must demand higher mathematical qualifications for primary teacher trainees (a grade C on Intermediate tier, taken some years previously, is not sufficient for anyone teaching mathematics, even at Key Stage 1).

Suggestions

- Restrict all mathematics teaching in primary schools to teachers who have achieved a grade A at GCSE or an AS/A-level qualification.
- Demand at least an AS-level in Pure Mathematics (and English) for entry into primary teacher training.

In the short term this might result in a lowering of entry numbers but in the long term it will result in primary teaching having a higher status and should eventually increase supply, whilst improving practice in mathematics teaching.

1.3 Training

As a long term strategy, and not just for training mathematics teachers, we would be keen to see the establishment of

University Practice Schools

in which student teachers spend their first periods of observation and teaching working with expert teachers and other future teachers in groups, planning collaboratively, observing together and participating in intensive evaluation sessions. In this way, critical reflection is encouraged and the student teachers learn not only from the expert teacher but also from each other.

Such schools, which would be akin to Teaching Hospitals in the medical profession, could be developed from the Government's training schools or from specialist schools for mathematics, and could also be used for

- university tutors to have opportunities to teach so that they do not become remote from teaching at school level
- university researchers to undertake experimental teaching programmes and to pilot proposed national initiatives
- regional in-service centres for continuing professional development (CPD) for mathematics teachers.

Fullan, in 'The New Meaning of Educational Change' (2001), describes how the University of Toronto prefers to work with cohorts of students (30 to 60), teams of instructors (university and school-based leaders) and clusters of partner schools. He characterises the school/university partnerships by saying that in these arrangements schools become just as committed to teacher education as to school improvement, and universities become just as committed to school improvement as they are to teacher education.

There is an interesting parallel here with the experience of school improvement in Japan reported in 'The Teaching Gap' (Stigler and Hiebert, 1999). The study describes the professional development activities of Japanese student teachers and teachers who adopt a 'problem solving' orientation to their teaching. According to Stigler and Hiebert, the major form of professional development is 'jugyou kenkuu' or 'lesson study'. In lesson study, groups of teachers and student teachers meet regularly over long periods of time to work on the design, implementation and testing of one or several 'research lessons'. Stigler and Hiebert maintain that the premise behind lesson study is simple:

> *"If you want to improve teaching the most effective place to do so is in the context of a classroom lesson ……... The challenge now becomes that of identifying the kinds of changes that will improve student learning in the classroom and, once the changes are identified, of sharing this knowledge with other teachers who face similar problems, or share similar goals, in the classroom."*

Suggestion

- University Practice Schools, or University Practice Departments in mathematics, should be established on a regional basis. These schools must exhibit effective and inspirational teaching of mathematics and be willing and able to play a key role in both pre-service and in-service provision and school-based research in their region.

1.4 Continuing Professional Development

The research evidence that is available on the effectiveness of CPD programmes is far from encouraging. Despite all the efforts and resources that have been utilised, the impact of such programmes in terms of improvements in teaching and better learning outcomes for pupils is disappointing (Fullan, 2001; Joyce and Showers, 1995).

Fullan (2001), provides the following summary of reasons for the failure of in-service education:

- one-shot workshops are widespread but are ineffective;
- topics are frequently selected by people other than those for whom the in-service is provided;
- follow-up support for ideas and practices introduced during in-service programmes occurs only in a minority of cases;
- follow-up evaluation occurs infrequently;
- in-service programmes rarely address the individual needs and concerns of participants;
- the majority of programmes involve teachers from many different schools and/or school districts, but there is no recognition of the different impact of positive and negative factors within the system to which they must return;
- there is a profound lack of any conceptual basis in the planning and implementation of in-service programmes that would ensure their effectiveness.

One of the four principles of the Key Stage 3 Pilot and Strategy has been transformation to '*strengthen teaching and learning through a programme of professional development and practical support*'. Although the training was generally well received the Evaluation Report (DfES, 2003) identifies some dissatisfaction

> *"Not everyone was positive about the training: over a fifth (21%) of the teacher survey respondents did not find the training by local education authority (l.e.a.) consultants effective, and more than a quarter (27%) felt that it had not prepared them well for teaching in the Pilot. There was some evidence of dissatisfaction with two aspects of the training: perceived rigidity of some of the presentations and reliance on cascade training."*

The criticisms of the cascade approach primarily concerned lack of time and the opportunity to cascade training adequately in schools. There was also evidence of a significant number of teachers who had barely been touched by the process and others who had limited contact.

Joyce and Showers' (1995) work on staff development, in particular their peer coaching strategy, has changed thinking about staff development. Joyce and Showers identified a number of key training components which when used in combination have a much greater power than when they are used alone.

The major components of training are:

- presentation of theory description or skill strategy
- modelling or demonstration of skills or models of teaching
- practice in simulated and classroom settings
- structured and open ended feedback (provision of information about performance)
- supporting application (hands on in classroom assistance with transfer of skills and strategies to the classroom).

Joyce (1991) also distinguishes between the two key elements of staff development activities - the *workshop* and the *workplace*. The *workshop* (the traditional INSET course) is where understanding is developed, demonstrations of the teaching strategy to be acquired are seen and practice carried out in a non-threatening environment. If, however, the skills are to be transferred to the *workplace* - the classroom and school, 'on-the-job' support is required. This implies changes to the workplace and the way in which staff development is organised in our schools. In particular it means the opportunity for immediate and sustained practice, collaboration and peer coaching and studying development and implementation. These changes cannot be achieved in the workplace without, in most cases, drastic alterations to the way in which schools are organised and their use of creative solutions to the problems of time and timing that beset on-the-job training.

One of the strongest messages from the evaluation of the Key Stage 3 Strategy (DfES, 2003) is the importance of time if meaningful change is to occur. Creating time was an issue for virtually all the schools and was particularly difficult in a period of teacher recruitment and retention difficulties. Almost all of the survey respondents reported that it had been difficult to find time to develop practice and 65% of school strategy managers cited time as a key challenge their school was facing.

Hence we propose, following the Esmée Fairbairn Foundation-sponsored evaluation of our current Teacher Training Agency (TTA)-funded modules (Burghes and Reynolds, 2003), that the cascade model should be replaced by school-based team initiatives in which the whole department works together, with at least one member (usually, but not necessarily, the Head of Department) acting as the 'leader' or 'facilitator', but with all members sharing their experiences, both difficulties and successes.

For example, each month (or bi-weekly) time should be made available and protected for two collaborative sessions. The first session would focus on the preparation of a particular lesson to be given by one of the staff, starting with the 'leader', and the second on reviewing its implementation (with as many of the staff as possible observing the dedicated lesson). Action plans for the whole department should result from each review and discussion, with team members teaching the planned lesson in turn.

This mechanism for using the internal power of the staff with the help of expert teachers is a far more effective way of implementing real change in classroom practice than the cascade model currently in use. Individuals can make a difference for their pupils but real improvement across the profession can only come from a team effort that is internal and **not** dependent on external influences.

Suggestion

- Time should be protected for a school's mathematics department to work as a team, with the expert teacher(s) acting as the facilitator and with all staff participating in shared planning, delivery, observation, review and discussion on a regular basis.

This is not to suggest that other forms of in-service should be abandoned but the evidence indicates that cascade models are **not** effective in changing the practice of departments. After all, there has been no shortage of CPD activity for mathematics teachers over the past two decades but reflection on the sustainable impact shows how ineffective our efforts have been.

1.5 Classroom Assistants

Classroom assistants are no substitute for real teachers and, with the emphasis on whole class interactive teaching where it is essential that the teacher is the focus of the class, can be a distraction for both pupils and teacher.

We are keen to rename classroom assistants as 'support staff' with the emphasis on helping the teacher (in primary schools) and the mathematics department (in secondary schools), with duties such as

- *preparing and adapting teaching resources*
- *finding useful internet sites and information*
- *marking work*
- *supervising pupils using computer instruction*
- *dealing with other paperwork.*

Suggestion

- Each secondary mathematics department to have a dedicated support person or administrative assistant and each primary school to have a team of support staff.

2. National Expectations and International Comparisons

There is undoubtedly a need for mathematics teachers, both primary and secondary, to have higher expectations of what their pupils can achieve. Whilst we recognise the move to 'set' for mathematics, very often now, even at Key Stage 1, the increasing pressure for pupils to achieve as high a grade as possible in national tests has led to a lowering of expectations of what many pupils could in reality achieve. Also the emphasis placed on particular targets (for example, 35% level 4 or above at Key Stage 2) leads to pressure being put on particular pupils and classes. It is important that we have high expectations of what **all** pupils can achieve in mathematics.

Suggestion

- Abandon targets in national tests for particular levels (or grades) but encourage and support schools and teachers to raise their expectations of what their pupils can achieve.

Mathematics is relatively easily compared across countries and it is important to continue to learn from good practice in other parts of the world (see, for example, Szalontai, 2000). The Qualifications and Curriculum Authority (QCA) 'World Class Tests' are a distraction and seem to have been developed as a commercial proposition rather than as research to improve practice. We need to have an open mind about practices in other countries, rather than thinking that we know best!

Suggestions

- Yearly tests should be developed and made available freely on-line to all, with a national representative database of results for comparison. Other countries should be encouraged to do the same, so that international comparisons can readily be made and regularly updated to show progress in participating countries.
- Researchers should be encouraged to investigate mathematics teaching in other countries and to use their experiences to influence mathematics teaching in the UK.

3. Curriculum Content and Pathways

3.1 Key Stages 1 – 3

Whilst we recognise the need to provide support and guidance for teachers through 'The Framework for Mathematics', this, together with the National Curriculum, has emphasised the view that mathematics is divided into distinct strands, for example,

number, algebra, shape and space, handling data, probability

that seem almost unrelated. Mathematically high-performing countries regard mathematics as an integrated subject so that, for example,

- algebraic concepts are embedded in early work on number,
- handling data is a natural application of mathematical concepts rather than a topic in its own right,
- probability is linked with fractions.

In this way, mathematics is seen as a whole subject, whereas our approach in both Key Stages 1 and 2 treats number and algebra as completely different and separate topics. For example, here are two approaches to a question met in Year 1:

$5 + \square = 9$

Current UK Approach		**Integrated Approach**	
T :	$5 + \square = 9$	T :	$5 + \square = 9$
P :	4	P :	$\square = 4$
T :	Well done!	T :	Why?
		P :	Because $5 + 4 = 9$.
		T :	What is on one side of the equals sign must equal what is on the other side.

So pupils for whom the integrated approach is stressed are ready and prepared for algebraic concepts that come later and already understand that the balance on each side of the equation must hold, i.e. whatever you do to one side you must do to the other. Many UK pupils never understand this concept, even after five years of algebra in secondary school!

One other issue is the role of **applications** in the teaching of mathematics. In the UK, considerable work has gone into providing resource material, particularly for Key Stages 2 and 3, to enhance and motivate the study of mathematics. Very little of this is now used in the classroom, partly because of the pressures of preparing pupils for national tests. This is particularly the case at Key Stage 3, where the optional yearly QCA tests are often imposed by the l.e.a., and there is little scope for integrating applications into the taught curriculum.

Many pupils feel that mathematics is an arid subject, irrelevant to the practical outside world, whereas our teaching should have an appropriate balance of mathematical topics and their applications of relevance to the pupils, not artificial contexts as have been used in the past. Areas of applications at Key Stage 3 could, for example, include

- *codes and cyphers*
- *transport*
- *entertainment*
- *finance*
- *sport*
- *environment*

but mathematics teachers will need more freedom in their teaching for this approach to succeed.

Suggestion

- The national curriculum for mathematics and the 'Framework for Mathematics' should be revised to stress an integrated approach with meaningful applications stressed, particularly at Key Stage 3.

3.2 Key Stage 4

The current GCSE scheme, reflecting the tiering in the assessment (see section 4.1), makes no sense. The curriculum is *not* academic enough to enable many students to progress easily to AS/A-levels in mathematics and is *too* academic for low achievers, who see no use in the watered-down academic approach that is reflected in the assessment.

For the future prosperity of mathematics, a radical new approach is needed. For example, the approach taken in English (with separate qualifications in English Language and English Literature) could be adopted, with two GCSE qualifications,

- **Practical Mathematics**
- **Academic Mathematics**.

The former would focus on the practical applications of mathematics to a wide area of contexts, regularly reviewed to reflect topical issues but designed to be a suitable end course for most participants. The latter would build on the current higher level GCSE syllabus, and would be designed to be a suitable foundation for A-level studies in mathematics.

This also leaves in place the GCSE

- **Statistics**

which is becoming increasingly popular. We recommend the promotion of GCSE Statistics as a suitable course for those wishing to continue on to A-level studies in topics such as Biology, Psychology, Accountancy and Economics. More mathematically inclined students could take both GCSE Statistics and Academic Mathematics.

Attitudes towards mathematics would be more positive if it were to be made an optional subject. Although most students would still opt for some mathematical study, it would be their choice rather than a compulsory subject.

Suggestion

- Mathematics should be an **optional** topic for study at Key Stage 4, and two distinct GCSEs in mathematics, namely

  Practical Mathematics GCSE

  Academic Mathematics GCSE

  should be developed alongside the current

  Statistics GCSE.

3.3 14 – 19 Portfolio

It is difficult to make precise recommendations here until overall policy on 14-19 education has been established. We prefer to have an educational system in which, from age 14, schools are divided into three faculties:

- **Academic**
- **Technical**
- **Vocational**

(with cooperation between neighbouring schools in cities, particularly with the vocational faculties, which should specialise in specific topic areas, for example,

car mechanics, tourism, healthcare, catering, decorating, horticulture

forging close links with local business and trade).

The mathematical support for each faculty should then be focused on their needs. However, if GCSE examination continues, the three proposed courses described in section 3.2, would be suitable.

3.4 Post 16

There have been far too many changes at this level and, although we are proposing yet more change, there should then be a five or ten year moratorium on any further amendments. Stability of provision must be a guiding principle.

At the moment there is far too much choice, reflected in the 6-module structure of A-level awards. We need to rationalise and simplify what is offered. The next change, with the core Pure Mathematics being extended from 3 to 4 modules, is unfortunate as it gives the impression that mathematics is all about pure mathematics unrelated to its applications.

As part of a 'Politeia' research project (Burghes, 2002), we surveyed what six other countries offered for this age group. It was soon evident that no other country has a framework as complicated and diverse as ours, so we strongly urge the Inquiry to simplify the current system.

If the GCSE proposals (section 3.2) were adopted, then we would propose A-level courses in

Mathematics (including applications in Statistics, Mechanics and Discrete Mathematics)

Statistics

and AS-level courses in

Mechanics

Discrete Mathematics.

Consequently we would anticipate most candidates taking an integrated mathematics course, except for those wishing to take more than one A-level course in mathematics and those for whom Statistics is a more appropriate course.

The Applied component of the Mathematics A-level course would be based on the integrated theme of mathematical modelling and include applications across the three broad areas of

Statistics, *Mechanics* and *Discrete Mathematics.*

Suggestion

- A-level provision should consist of full A-level courses in

  Mathematics (including applications)

  Statistics

  and AS-level courses in

  Mechanics

  Discrete Mathematics.

Mathematical support for other students, that is, those not requiring A- or AS-level qualifications, is dealt with in section 4.4. It should be noted, though, that mathematics is given too much importance and, for many students, fewer mathematical skills are needed for the workplace and everyday living than in the recent past. We fundamentally disagree with the often quoted view that what everyone needs is *more* mathematics - in fact, most people need far less! Of course, there is a small number who do need more at a more advanced level, and, in this technological age, concentrating on different concepts (for example, critical path analysis for business managers).

3.5 Progression/Interface

A summary (DfES, 1999) of the research on the impact of primary to secondary school transfer on pupils' progress and attainment concluded that after secondary transfer a significant number of pupils in year 7 suffered from anxieties caused by adjusting to a new routine. They also faced repetition of work already covered and low expectations, a longer summer break prior to transfer before previous knowledge and skills had time to be embedded, and organisational structures that promoted negative self esteem for some of them.

The DfES Report revealed that there were five main categories of activity which schools employ at the point of transfer. The five ' bridges', outlined by Michael Barber in the publication 'Crossing the Bridge' (2002), are:

1. The **bureaucratic** bridge - involving formal liaison between schools
2. The **social** bridge - involving the development of social links between students and their new schools
3. The **curriculum** bridge - sharing plans for the content to be taught
4. The **pedagogy** bridge - to develop shared understanding of how students are to be taught
5. The **management of learning** bridge - involving the empowerment of the student and family with information about achievement and needs.

Evidence from the DfES report 'Preparing for Change' (2003) indicates that most secondary schools and their feeder primary schools are involved to a lesser or greater extent in 'bridges' 1,2 and sometimes 3. Evidence from the same report indicates that there is little evidence of 'bridges' 4 and 5 being undertaken by schools.

Enhancing progression between Key Stages 2 and 3 has been a particular aim of the Key Stage 3 Strategy. Examples of successful practice are cited such as the literacy and numeracy coordinators from five schools (the pilot school and four feeder primary schools) and the secondary English and maths teachers timetabled to work together over a year. However, whilst there were some examples of good transfer procedures, practice on the whole seemed to be patchy and mixed.

'Other schools appeared to be at an earlier stage of establishing links and dialogue between Key Stage 2 and Key Stage 3 with few teachers visiting primary classes and less understanding of the primary classroom.'

Suggestion

- A collaborative research project should be undertaken by Higher Education and a group of secondary and feeder primary schools to consider the development of good practice in Key Stage 2 to Key Stage 3 transfer. The project should encompass the principles and practices set out by Michael Barber in his five 'bridges'. For instance, Key Stage 3 mathematics teachers would be given opportunities to teach in Key Stage 2 feeder primary schools for a regular and sustained period of time and vice versa.

3.6 Implications of ICT

There is as yet no clear evidence that using ICT is a particularly effective way of teaching mathematics (Gardiner, 2001 and Higgins and Muijs, 1999). There are some areas, for example, the simulation of probability experiments, where it is both effective and motivating, but care must be taken. Most commercial software currently available is not as effective as a good teacher and is very expensive.

The ICT approach must be integrated within the scheme of work being used, rather than regarded as an extra. Significant research and development is needed to develop software approaches that enhance the way particular topics are taught in the classroom but this should be undertaken as a government initiative rather than as a commercial activity. The on-line BBC resources might provide something worthwhile but as yet this initiative seems to have stalled in the face of software industry pressure. This is most unfortunate.

Suggestion

- Software should be developed and trialed as a national initiative so that all mathematics teachers have free access to the effective approaches that can support and enhance their teaching. (This could be an activity coordinated by the proposed 'Centre for Excellence in Mathematics Teaching'.)

We have made further precise suggestions for ICT development in section 6.1.

4. Qualifications, Assessment and Testing

4.1 Key Stage 1 – 3

The current system of regular testing and national reporting of schools' results in performance league tables is a policy that is not in the best interests of anyone. Pupils are put under too much pressure, teachers are stressed, parents are unhappy and dissatisfied - it is a highly unsatisfactory system and we urge this committee to do what it can to improve the situation. Complete abolition of the system, particularly the national reporting of test results, should be a top priority.

It is of interest to note that this has been done in Wales, with the announcement that Key Stages 2 and 3 will be abolished within 2 years and where Key Stage 1 testing has long since been abandoned.

This is not to say that we are against having national tests as a means of informing pupils and parents of the progress being made. Indeed having freely available (national curriculum levelled) national yearly tests on the internet, password protected, and with instant feedback, would be an excellent way of providing useful diagnostic information for pupils, parents and teachers.

Michael Fullan and his colleagues (Earl, 2001) suggest that most of us would agree that a move to high standards is necessary and important. However, he points out that there is less agreement about the way tests and targets are used in the process. Olson in 'The Education Week' (2001) in the United States points out that although testing can be a powerful tool to change what happens in classrooms and schools, these changes are not always positive.

> *"Of the most concerning are two practices - diverting time from teaching the curriculum to teaching pupils how to take tests, especially in the months directly before the tests are given, and shifting time away from non-tested subjects towards tested subjects."*

Fullan makes the comment that in phase one of the implementation of NLS and NNS (1997 to present) focusing on Key Stage 2 tests and setting targets was likely beneficial. He suggests that:

> *" ... it got people's attention and enabled the system as a whole to mobilise.'"*

However, he adds a cautionary note:

> *"The high visibility of the 2002 Key Stage 2 targets, the percentage of children who reach level 4 - has meant that, in effect, the Strategies are being judged, at least publicly, on their success at meeting one criterion. NLS and NNS however are complex initiatives, based on frameworks that guide teaching in primary schools in a variety of ways: their success and impact cannot be fully assessed by a single measure."*

He notes that preoccupation with single achievement scores can have negative side effects, such as "*narrowing the curriculum that is taught or wearing people out as they focus on targets*". He also suggests that there should be less emphasis on testing and target setting if we are to move from implementing the technical aspects of the strategies to achieving deeper pedagogical changes implicit within those strategies.

There has also been much discussion and encouragement for gifted and talented pupils to take, for example, GCSE qualifications at an early age. We do not see any merit in this as the evidence would appear to strongly indicate that it is not in their long-term interest, but further research is needed. We would prefer to see such pupils given access to the broadest range of mathematics.

Suggestions

- Develop freely available yearly national tests (for Years 1 - 9) that provide National Curriculum levels and diagnostic feedback.
- Undertake detailed research into the impact of very early entry to GCSE mathematics examinations.
- Develop resources to broaden the Key Stage 1-3 mathematics curriculum for gifted and talented pupils.

4.2 GCSE

We have already dealt with the suggested changes to the Key Stage 4 curriculum in mathematics; there are two important issues that need debate in terms of the assessment.

4.2.1 Coursework There was great enthusiasm for the idea of coursework when it was first introduced as it was felt that it would enable students to use their mathematical skills in practical situations or to extend their mathematical knowledge. In practice, we now have essentially a piece of bookwork with a tight marking scheme, with the outcome often very much dependent on how much help is provided by teachers and parents (and by plagiarism from the internet - if you use a search engine, for example, Google, on a particular coursework topic as set by the examination board, you can get a completed project, for no fee and no effort!). Our conclusion is that, for GCSE Mathematics at least, formal coursework should not be part of the assessment.

Under very different conditions, we do see that it could play a part in the assessment of a GCSE in Statistics and Practical Mathematics, but fundamental changes are needed to the way the work is set, organised and marked.

4.2.2 Tiering We have argued, since the start of our *Mathematics Enhancement Programme (MEP)* some 8 years ago, for the abandonment of an assessment framework in which

(a) there are overlapping tiers so that particular grades can be achieved in more than one way,

(b) there is a tier on which it is impossible to achieve the all-important grade C (essentially you have 'failed' even before you sit the exams - only mathematics assessment has this feature!).

We appreciate that there is (at last) a pilot non-overlapping tiering system being run by the examination board OCR (an earlier trial was undertaken in 1998 (Burghes et al, 2001) which showed that an alternative model with an optional paper for higher grades worked well). It is a matter of urgency that this type of system, which, incidentally, has been used for a number of decades for examinations in Scotland, should become the national practice here. You can then have a system of non-overlapping tiers such as, for example,

A*	A	B
C	D	
E	F	G

for GCSE *Mathematics* with candidates able to enter one or more of the tiers, and the highest grade achieved on any tier is their award. Alternatively, for GCSE *Statistics* or GCSE *Practical Mathematics*, you could have two tiers, such as

A*	A	B		
C	D	E	F	G

It should also be noted that, as far as we know, no other country has a framework of overlapping tiers - it is immediately obvious that it is unsuitable for the consistent and unambiguous awarding of grades.

Suggestions

- All GCSE examinations in mathematics should use non-overlapping tiers, with candidates being able to enter any (or all) tiers and being awarded the highest grade obtained.
- Coursework should be abandoned for GCSE Mathematics and extensively revised (in the way it is set, supervised and marked) for other mathematics GCSE courses.

There is one further issue that has recently become popular and that is the use of *modular assessment* for GCSE. We feel strongly that this is inappropriate for students of the normal age, and, if used at all, should be restricted (as it was until recently) to mature entry candidates. Our reasons for this are that modular courses tend to emphasise a 'compartment' model of mathematics rather than an integrated approach and that what is examined in the first year of a two-year GCSE course will not be of the same standard as would be expected at the end of the second year, by which time students will have matured considerably.

Suggestion

- Discontinue modular GCSE Mathematics for students of normal age.

4.3 GCE (AS, A-level, Further Mathematics, Advanced Extension Award)

In section 3.4 we outlined a proposed new simplified structure for A-level courses.

Whilst the current modular route does increase accessibility, the cost in terms of options, availability and restricted combinations make the whole package extremely clumsy, confusing and complex! We would prefer to see a simplified scheme in which AS has the same esteem as A-level, but has half the content size.

In this way, we propose, in line with our earlier proposals in section 3.4, AS assessment in

Mathematics

Statistics

Mechanics

Discrete Mathematics

with one 3-hour examination for each award, and a second 3-hour examination in

Mathematics

Statistics

in order to complete full A-levels in 'Mathematics' and 'Statistics', with the option of taking 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$ or even 3 mathematics related A-levels.

This scheme is much more straightforward, with sufficient options for choice and student interest.

Suggestion

- Incorporate AS-level awards, each with one 3-hour examination, in

  Mathematics

  Statistics

  Mechanics

  Discrete Mathematics

  with A-level awards gained from two further 3-hour examinations in

  Mathematics

  Statistics.

4.4 Other National Mathematics Qualifications

We recognise the value of the freestanding mathematics units but would still prefer to see these incorporated into the AS/A-level proposals.

4.5 Application of Number

We have already dealt with this issue in the proposal for GCSE courses in both 'Statistics' and 'Practical Mathematics'. We do not see the need for yet further qualifications or courses unless related to the available assessment.

4.6 Awarding Bodies

There should be ONE examination board for England. The current system, with several examination boards competing for candidates, is neither efficient nor fair. With just **one** national examination board, there would be no need for a body such as QCA, which is to blame for almost every wrong decision made in examining in the past 10 years. The current uneasy alliance between QCA and the examination boards, where the boards do not dare to say to QCA that their proposals are unworkable and/or misguided, has continued for far too long.

It is high time that QCA was wound up, together with its considerable staffing (over 1000 now) and its countless consultants (over 300 at the last count) and consultative committees (which often tend to be a sham as they know at the outset the answers they wish to reach). QCA has, in short, been a recipe for mayhem, disaster and confusion over the years. It is time that someone was brave enough to stand up and be counted and disband this quango to stop further damage being done.

The examination boards undoubtedly have the expertise and it is unfortunate that they have not wanted to amalgamate into one efficient service for education.

Suggestions

- Amalgamate examination boards into ONE national examination board, set up to provide an efficient and effective *service* for education.
- Disband QCA forthwith.

5. Pedagogy

The Government's initiatives at both Primary and Key Stage 3 have at least opened up the debate on pedagogy in the classroom, although the resulting 3-part lesson has rather dominated both initiatives to the extent that many mathematics teacher now feels that they *must* teach a 3-part lesson, writing their objectives and key words on the board at the start of every lesson! Whilst this procedure can result in an effective lesson, our research indicates that it is the weaker teachers who are supported by this 'tick-box' type of recipe whereas more experienced and effective teachers are often disillusioned by the restrictive and blinkered approach shown by many (NNS and Key Stage 3) consultants.

Again, this seems unfortunate as there is probably much that we can all agree on in terms of a successful pedagogy for teaching mathematics. For example, most mathematics educators would agree on the benefits of

- clearly specified schemes of work,
- a planned combination of interactive whole class teaching and individual work,

- teaching with pace, enthusiasm and humour, continuously monitoring the progress of all pupils,
- clear, precise description of the topic or concept being taught,
- high quality interaction with a whole class ethos, pupils working at the board, all pupils kept on task and individual work thoroughly monitored,
- mathematics correct and precise at all times, whether spoken or written,
- mistakes used as teaching points for the whole class,
- emphasis on mental and oral work, particularly in the early years,
- limited calculator use, and only when pupils have gained competence in basic numeracy, and then used effectively and efficiently,
- meaningful investigations used only when appropriate,
- applications related to real life used where possible,
- lessons well prepared; board prepared; relevant teacher resources close at hand; pupil resources on desks,
- seating at desks facing the board, or similar arrangement which facilitates whole class interactive teaching and allows easy access to the board,
- homework set after each lesson in secondary schools to reinforce the concept and prepare for the next lesson; homework reviewed interactively at the start of the next lesson,
- pupils encouraged to demonstrate and articulate in front of the class and class to agree/disagree, point out errors or offer alternative methods of solution,
- low ability pupils given extra lessons where possible to reinforce concepts,
- mathematical reasoning and logic emphasised and opportunities given for creative thought.

The research shows that there is a striking quality to fine classrooms. Students are caught up in learning, excitement abounds; and playfulness and seriousness blend easily because the purposes are clear, the goals sensible, and the unmistakable feeling of well being prevails.

Expert teachers achieve these qualities by knowing both their subject matter and their students; by guiding the learning with deft control - a control that itself is born out of perception, intuition and creative impulse.

In encouraging teachers and others to think about their own ways of working, Lawrence Stenhouse (1981) developed the concept of 'the teacher researcher' where teachers were encouraged to experiment with the 'specificity' rather than be bound by the prescription. When teachers adopt this experimental approach to their teaching they are taking on an educational idea, cast in the form of a curriculum proposal, and testing it within their classrooms.

Referring to his evaluation of the National Numeracy Project, Fullan (2002) asks if the changes are deep and lasting:

> *"We don't think so. Don't get me wrong. The gains are real and they represent not a bad day's work - to get millions of pupils reading and engaged in numeracy. But they do not represent the*

kinds of transformation in teaching and learning that are being identified by cognitive scientists, or the closing the achievement gaps for disadvantaged groups. The gains are neither deep nor lasting because we don't have any evidence that the learning cultures in schools have been transformed. We don't, in other words have any reason to believe that the professional learning communities are part and parcel of the strategy. Without the latter we will not see the problem-solving and internal commitment needed for substantial and continuous reform.

To summarise, they [the government in England] *have not yet seriously acted on capacity-building, and they cannot do so effectively with the present strategies. Rather the next stage of advance is the creation and fostering of professional learning communities where local schools evolve to leading their own destiny within a framework of accountability and support."*

So there needs to be a re-focusing of what the Government's national projects are recommending, with genuine freedom given to teachers encouraged in any implementation. In this way, we can learn from best practice, but no progress will be made if we continue to use cascade models for effecting change (see section 1.4).

Suggestion

- The Mathematics Education community, rather than the Government, should unite on guidelines for good practice in mathematics teaching and capacity building in schools and recognise and value diversity and innovation.

6. Teaching Resources

6.1 ICT

There has been much pressure on mathematics teachers, primary and secondary, to use ICT to enhance their teaching of mathematics but there is little sound research evidence to support this pressure. More research and development is urgently required to see what software for whole class interactive teaching and for individual work is worthwhile, and how interactive whiteboards can be best used in the classroom.

Clearly there are situations in geometry (for example, transformations) and probability (simulating experiments) for which ICT can prove a very powerful tool. It would, for example, be helpful if there was coordination to find and/or develop a suite of useful programs that could be made *freely* available to all teachers.

There is also a further use of ICT for extra tuition and revision, particularly useful where this can be integrated in the scheme of work being used. The whole area of diagnostic testing is still in its infancy, even after two decades of piecemeal development. Computers are ideal for testing as they can give instant feedback, but with sufficient development they should also be able to provide relevant advice and support, having been programmed to recognise the errors being made.

So there is much to be developed but it does need to be coordinated, researched and good practice disseminated, preferably with free software given to all mathematics teachers.

With the shortage of high quality teachers, we would like to see, in the near future, more use made of ICT in actually delivering lessons so that the effective teacher's expertise can be spread more widely. For example, at Key Stage 3, *two out of every three* lessons could be given by the effective teacher with the *third* lesson being computer based but with the content integrated with the scheme of work being used. This could be supervised by teaching assistants or other teachers. We are not suggesting that this would be better than having a good teacher for all lessons, but it should be more effective than poor teaching and/or supply cover.

Suggestions

- More research and development is needed to determine and disseminate useful software for enhancing the teaching of particular topics.
- Research and development into diagnostic testing.
- Development at Key Stage 3 of an integrated approach to lessons, based on using computers for one out of every three lessons.

Finally, it would be helpful to have a free website dedicated to providing mathematical resources, targeted at specific ages and National Curriculum Levels, relating to topical issues of the moment. For example, in early June topical issues could include

- ranking models in tennis (Wimbledon does not use the accepted world rankings)
- statistics relating to delays on the national rail systems (at regional and company level)
- analysis of congestion charges (impact, revisions, costs)
- investigations of football transfer fees, wage bills and league positions of clubs
- correlation of hay-fever effects and weather characteristics.

The data would need to be constantly changing, would reflect the use of mathematics in topical (and relevant) news stories and would be freely available to pupils and teachers.

Suggestion

- Develop topical mathematical resources for pupils on a website, regularly revised and updated and with interesting statistics available or linked.

6.2 Textbooks

These should be left to the commercial world but the examination board sponsored textbooks, written by chief examiners, should be banned. Under the current system or with only one examination board (see section 4.6), any examiner should remain anonymous and not be able to advertise their status as an examiner. Similarly, no examination board should be allowed to give a particular series official status.

Suggestion

- Textbook provision should be independent of examination boards and their examiners.

6.3 School Organisation

We have already mentioned several important aspects that relate to school organisation. These centre on the role of the Head of Mathematics in secondary schools, where we want to encourage the department to work as a team, sharing ideas and best practice.

Research into secondary schools' academic effectiveness, for example Harris et al, (1996), highlights the importance of subject departments and, in many schools, departmental or subject cultures differ from those of the whole school. The research points out that the subject leader can greatly influence the quality of teaching within their subject and leadership is now recognised as a central peg in whole school improvement.

Findings in the Key Stage 3 evaluation also suggest that the extent of success of a particular strand was in large part related to the effectiveness of strand leadership. Case studies from the pilot suggested that successful strand leadership includes a range of characteristics:

- supporting pilot principles
- well respected by colleagues
- energetic and committed
- good communicator and listener
- aware of the development needs of the department
- understanding the change process
- effective use of consultant
- effective use of data and target setting
- observing lessons, facilitating peer observation and giving model lessons
- using department meetings to share ideas.

So the senior management need to support the Head of Mathematics and the mathematics team by the following actions:

Suggestions

- Protected time should be allocated for CPD.
- Mathematics should be given priority in the use of ICT facilities for planned, integrated courses.
- A dedicated mathematics administrative assistant to be provided to support the mathematics team so that the Head of Department is not engaged in low level maintenance tasks.
- Mathematics should be timetabled, wherever possible, for early in the day.

6.4 Extra Curricula

Many schools, l.e.a.s and Higher Education institutions undertake a range of outside activities, for example, maths trails, master-classes, homework support and summer schools.

These should be encouraged but they should be seen as *optional s*upport and no school policy should be dependent on such activities.

There are also many websites giving stimulating problem solving activities and/or tutorial support. These should be supported so that high quality material is freely available to all.

7. HE Requirements/Transition Problems

7.1 Mathematics

Many HE institutions have been very vocal in complaining about the quality and depth of school mathematics. This can be counterproductive as can be seen from the recent A-level problems in which Mathematics alone kept the A-level standard for AS examinations. If A-level mathematics becomes a significantly more difficult course than all other subjects, numbers of candidates will continue to plummet. We certainly want to see standards improve and have sympathy with HE colleges when they have to 'pick up the pieces', but any significant improvement has to start at Key Stage 1 and work its way through the system.

It is a long term strategy; in the short term, HE colleges should collaborate with A-level teachers (shared observations and teaching) and be willing and ready to help both in raising standards and in clarifying what is important for future study.

Suggestion

- Higher Education staff in mathematics should collaborate with and support A-level teachers.

7.2 Science and Engineering

Similar comments apply here as in section 7.1 above. Too often there seems little appreciation of the problems and difficulties currently faced by school teachers. Whilst it is clear that in the long term standards need to be raised, in the short term HE needs to address some of the current problems. HE has considerable funding in comparison with schools to provide suitable support for students who need more mathematical skills and knowledge. The development and use of ICT support, for example, needs to be encouraged, with universities sharing their ideas rather than each, in practice, re-inventing the wheel.

The last two decades have seen a significant increase in the percentage of pupils continuing into HE. This inevitably leads to tension over standards and, unless this policy is reversed, both schools and HE will continue to have problems in enabling their students to succeed without lowering standards.

Suggestion

- HE institutions should undertake to provide ICT-based mathematical support, specific to the needs of the particular department.

7.3 Social Sciences

Similar comments apply here, although it should be recognised that many of the HE students in these disciplines will only have a (possibly low) mathematics GCSE qualification. The departments, though, must recognise this and build on the current level of mathematical understanding. Too often lecturers seen unable to appreciate the mathematical problems that these students have; ignoring these difficulties leads to failure in the future.

As with science and technology students, sympathetic support is needed both to raise standards and to find suitable short term solutions.

8. Adult Numeracy

With the current situation of overall low levels of adult numeracy there does need to be support for people who wish to rectify their knowledge gaps. We again think that ICT support has, potentially, a role to play as it can provide

- instant feedback
- diagnostic support
- tutorial support

and, crucially, can be undertaken without anyone else seeing the outcomes. This is not to say that interactive tutorial human support is not also important!

Suggestion

- Comprehensive ICT support for adult numeracy should be developed from a foundation in mathematics, using relevant contexts and made freely available for use, in confidence if preferred, by adults.

9. Employer Requirements

This is a complex area as the mathematical needs of employees depend on

- the type of industrial/commercial organisation
- level of employment
- prior mathematical knowledge.

Whilst many mathematics educators have been prominent in commenting that "more but different mathematics" needs to be taught to students or young employees, we do have reservations about the over-emphasis on mathematics.

There is no doubt that some (a minority) of young employees will need more mathematics than they have been taught for their future employment but in our IT based world, the majority will actually need far less! They will need to be able to use and understand databases and spreadsheets, but not many will need to know how the spreadsheet works!

The mathematics education community should not be frightened by this, but should accept the opportunities that arise. We support at least part of the view of Simon Jenkins (2003) in *The Times* in which he correctly recognises that much of traditional mathematics has been overtaken by the IT revolution. This, though, does not mean the demise of mathematics, as a minority of young people will actually need more mathematics in their training.

We need to provide a rigorous foundation in mathematics at school level for those who will need to build on this foundation into more advanced mathematical theories, and practical expertise for the majority who need to be numerate and able to use mathematics with confidence and competence in real life contexts.

With this background, employers should be left to provide the support needed in specific and dedicated areas.

Suggestion

- The mathematics education community should build on the changing mathematical needs of employment, recognising that many young people will need *less* mathematical expertise in the future, but that a minority will need *more.*

10. National Strategies and Policy

10.1 National Numeracy Strategy (NNS)

We are pleased that the implementation of the NNS has led to a focus on mathematics (for example, lessons each day), and in particular, improvements in mental mathematics skills.

It is unfortunate that numeracy has dominated as we believe that even higher levels of numeracy would result from a better *mathematical* foundation. We have already dealt with other concerns in section 5, and if the NNS continues, we strongly recommend that it concentrates on providing support for an integrated mathematics course, much more closely aligned to Continental practice.

Suggestion

- The National Numeracy Strategy should re-focus its activities by concentrating on integrated mathematics courses.

The role of the numeracy consultants and the 'leading mathematics teachers' also needs fundamental change. Many appointed consultants do not have sufficient mathematical understanding to do their job effectively and hence rely on the multitude of overhead transparencies that have emanated from NNS, seemingly unable to think for themselves.

The Key Stage 3 Strategy Evaluation report (DfES, 2003), describes how consultants provided the central training on their specialist area or provided input for a broader course, for example, approaches to assessment. It suggests that they also provided school-based training for all staff departments, voluntary groups and individuals through presentations, classroom activities, modelling, team teaching, observations and evaluations.

Responses from those involved with NLS, NNS and KS3 Strategy were quite positive but often mixed.

> *"The LEA consultant delivered the material exactly as scripted so there was no opportunity to ask questions or give feedback. I could have read the material just as easily."*
>
> (primary headteacher)

> *"The consultant came in once, did a sample lesson, and talked to us as if we knew all about it. But we didn't."*
>
> (primary teacher)

Also, the leading mathematics teachers initiative was totally devalued by the use of volunteers rather than recognised and chosen expert mathematics teachers.

Suggestion

- Only mathematically confident and competent staff should be used to support schools, and the leading mathematics teachers scheme should be abandoned unless a system of quality control can be introduced.

10.2 Key Stage 3 Strategy

We have very similar comments here as in section 10.1 above in terms of personnel. Also, the focus should be the pedagogy of teaching rather than the sequencing of topics, with an integrated Year 1 to Year 11 strategy for mathematics, and the power for change must be developed internally (see sections 1, 4 and 5).

Suggestion

- There should be no Key Stage 1, 2 and 3 strategies but a Year 1 to Year 11 integrated strategy for mathematics.

10.3 QCA

We have already dealt with this issue in section 4.6, where we advocated one national examination board for England amalgamating AQA, OCR and Edexel. QCA should be disbanded; we see absolutely no benefit in continuing this highly expensive quango and all its consultants (most of whom left teaching some time ago and are out of touch with the current school situation).

10.4 OFSTED

As with QCA, this organisation needs either to be disbanded or totally revised. It is yet another quango that eats money and employs thousands of part-time inspectors to questionable effect. To have competition for inspections reflects the worst excesses of the Government of the 1990's. Surely it is time to bring common sense into play rather than spurious ideological arguments.

Suggestions

- Replace OFSTED with full time, regionally based inspectors (who have an established track record of expertise in teaching and subject specialisation!).
- Inspectors should be allowed to visit schools, without notice, at any time, and to go anywhere in the school.
- Only when there is real cause for concern should action be taken (for example, Head of Department will be asked to formulate an action plan).

The current inspection process, even with the 'light touch', provokes stress, mountains of unnecessary paperwork and a tick-box mentality regarding teaching. Research undertaken for the Liberal Democrat Party showing that the national examination results of schools being inspected declined in their inspection year should be taken seriously.

10.5 TTA

We have no strong views here; the current organisation has tried hard to recruit teachers but the quality of some of those entering the profession is dubious.

Part of the problem for this (and the previous) Government is the number of quangos and the conflicts of interests between them. The number should be reduced and work coordinated so that, for example, the TTA should be a department within DfES rather than a separate body.

Suggestion

- Integrate the role of the *TTA* within the DfES and ensure that different agencies and quangos are not competing for work.

10.6 Existing and Future Policy

These have already been addressed throughout this submission.

11. Attitudes and Perceptions

In the press and in education, mathematics is regarded as a complex and difficult subject. This is both unfortunate and not true! Yes, it is a very linear subject, in which new mathematical concepts are based on previous ones, but at its heart it is a logical straightforward subject. It is only in its teaching that it is made into a difficult subject. We need to adopt the attitudes of other countries which see mathematics as a straightforward, interesting and relevant subject.

Recent research evidence (Grimes, 2003) suggests that the more individuals are trusted, the more trustworthy they become. Our children will grow into competent and confident adults if their views and ideas are acknowledged and they are encouraged, with guidance, to trust their own judgments. Within a responsive and sensitive environment, creativity will flourish as the future generation grapples with problems and issues, endeavouring to find workable solutions. Teachers should be valued for the very important job they carry out daily. By being secure and respected they will have an enormous positive effect on the pupils in their care.

12. Proposed 'National Centre for Excellence in Mathematics Education'

This section has been added to the original list of Key Issues presented by the 'Post-14 Mathematics Inquiry'.

The announcement by the Secretary of State earlier in the year seems to make this proposed centre a fact rather than something to be discussed and debated.

Whilst we welcome the prominence given to mathematics education by its establishment, we are concerned about its long term effectiveness and indeed its relationship with other stakeholders in mathematics education. In particular, we are concerned that it will prove to be an excellent public relations opportunity for the Government with the perception that its establishment alone will solve all our problems, but comparison with other 'centres of excellence' does not give cause for optimism for the long term effect.

Having said this, we can see that many of the suggestions made in this response could be coordinated through such a centre, as long as the centre took the role of catalyst in improving mathematics eduction and was able to harness the many successful and worthwhile activities in mathematical education that already happen locally in

schools, colleges, l.e.a.s, universities, etc.

We should also add that the proposal for University Practice Departments (section 1.3), if implemented, would provide suitable regional 'centres' that would not be too far away from real teaching (which is the main problem with most such centres) and would then at least have local credibility in the region amongst teachers and mathematics educators.

For example, we could see the National Centre coordinating and/or developing and disseminating, possibly through the regional centres,

- yearly national diagnostic tests for mathematics (sections 2.3 and 4.1),
- resources to use the applications area of mathematics in teaching (section 3.1 and 6.1),
- resources to broaden and enhance the mathematics curriculum for gifted, talented and creative pupils (section 4.1),
- Practical Mathematics GCSE (section 3.2),
- high quality software to support mathematics teachers (section 3.6),
- a united approach to pedagogy (section 5),
- integrated ICT based Key Stage 3 courses (section 6.1),
- findings from national and international research.

So, in our view it is the way the proposed National Centre operates that will be significant for its success.

On the one hand, it could unite the innovative and worthwhile projects already under way, giving them wider and more effective dissemination by working collaboratively with the many individuals and organisations involved in mathematics education. On the other hand, it could take a far more dictatorial and dominating approach which would alienate much of the mathematics education community and, indeed, it would then be competing with many other stakeholders for funding. This would be most unfortunate; we strongly advise the use of collaboration and cooperation, but it will not be easy!

Suggestions

- Any National Centre for Excellence in Mathematics Education should build on the strengths of the many stakeholders in mathematics education, collaborating, delegating and coordinating rather than competing for the action and the funding.
- National initiatives that would be suitable for the Centre to coordinate include

  yearly national diagnostic tests for mathematics,

  resources to use the applications area of mathematics in teaching ,

  Practical Mathematics GCSE,

  high quality software to support mathematics teachers,

  a united approach to pedagogy,

  integrated Key Stage 3 courses.

- The proposed National Centre should disseminate mathematics activities through regional and local centres, ideally University Practice Departments in schools.
- The National Centre should *freely* provide the results from activities proposed above and not be set up as a commercial operation.

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