Association of Teachers of Mathematics
www.atm.org.uk

ATM's response to the final report of the 'Tomlinson' working group on 14-19 Curriculum and Qualifications Reform in the light of the 'Smith' report *Making Mathematics Count*

This response was written by a working group of ATM members in consultation with the General Council of ATM. The working group comprised a recently retired HMI, two teachers, each with over 30 years experience of teaching the 14-19 age group in both schools and FE, and university lecturers in mathematics and mathematics education.

Introduction

ATM welcomes the opportunity provided by both the Tomlinson report and the Smith report to rethink the educational opportunities offered to students aged between 14 and 19. Currently, only 42 per cent of all 16-year-olds achieve grade C or better in *both* mathematics and English GCSE (Tomlinson 62) and 48 per cent achieve a grade C or better in mathematics. Hence, at the moment half the population does not achieve a level 2 qualification in mathematics by the age of 16. But even among those who do currently achieve this qualification, only 20 per cent choose to study AS or A2 mathematics (level 3). Both the Tomlinson and the Smith reports rightly emphasise the importance to the country of increasing this figure and ATM believes that the only way this will happen is if young people are challenged and inspired by the mathematics teaching they experience prior to the age of sixteen. Currently, too many young people are bored in their mathematics lessons, some because they do not feel challenged and others because they do not see the relevance of the curriculum to them. These reports provide a unique opportunity to consider how young people can be helped to have a positive attitude to and confidence in their ability to succeed in mathematics. Both the quality of teaching and the curriculum itself need to be considered. The flexible pathways suggested by both the Smith and Tomlinson reports, with the emphasis on learners making choices about what they learn and when, are likely to be helpful when considering how to improve the current situation. Both reports provide us with a sound basis on which to build.

Pathway models for 14-19 mathematics

We strongly support the principles guiding the construction of pathways in mathematics listed in paragraphs 4.43 and 4.44 of the Smith report. There is one significant difference between the four pathways for mathematics suggested in paragraphs 4.49 to 4.59 of the Smith report and the pathways suggested in Chapter 3 of the Tomlinson report. Consider a student embarking on KS4. The Smith models provide this student with a choice of appropriate mathematical pathways that are developmental: once one has mastered 'Numerical literacy' at level 1 (to use the first model suggested in figure 4.2 as an example) one can move on to 'Quantitative literacy' at level 2. In the Tomlinson model, the learner appears to have to follow two pathways: one leading to a level 1 or 2 qualification in functional mathematics and the other leading to some other qualification which, it is suggested, will be a GCSE grade in mathematics. To deal with this problem, Tomlinson suggests developing 'extended components' (paragraph 92) which cover both the core requirements *and* the 'broader or more theoretical and conceptual' aspects of the subject and in Annex C it is suggested that these extended components should 'avoid the need for separate delivery/assessment'. However, the 'mastery' model for the assessment of functional mathematics, suggested in paragraph 164, and the requirement in paragraph 165 that the functional skills should be clearly identifiable in the assessment is totally inconsistent with the current model of assessment of GCSE. This alone will make it difficult for teachers to plan a coherent scheme of work for KS4 mathematics.

What mathematics is compulsory at KS4?

In the previous section we pointed out the inconsistencies between the models suggested by Smith and by Tomlinson and our reservations about the Tomlinson model. However, there appears to be general acceptance of the Tomlinson model and we are going to assume for the rest of this response that a 'functional mathematics' qualification is going to be developed. We shall discuss how this could be made most effective in improving the mathematical skills of young people and encouraging more of them to continue studying mathematics beyond level 2.

There are inconsistencies in the Tomlinson report. Recommendation 5 states that 'all 14-16 year olds should be required to follow the statutory National Curriculum at KS4'. The Mathematics National Curriculum at KS4 is assessed by GCSE. Tomlinson suggests that the functional mathematics course is likely to occupy only between 50% and 80% of GCSE. Hence, it would appear that *all* students between the ages of 14 and 16 have to study more mathematics as part of their 'main learning'. Yet, according to paragraph 91 'young people must have *access* to wider or more conceptual and theoretical mathematics' and in Annex C (page 12), one of the choices suggested is 'a free-standing core for those not studying a wider, general programme'. These statements imply that KS4 students do not *have* to study any mathematics beyond the core.

Our view is that, *if* an appropriate functional mathematics qualification can be constructed (see next section), then this should be the *only* compulsory mathematics at KS4. Others argue that we need the vast majority of KS4 students to study 'main learning' mathematics if we are to improve their mathematical skills and increase the numbers proceeding to level 3 mathematics. We do not agree with this. Currently, half the KS4 cohort fails to achieve level 2. If a significant proportion of these 'failures' study only a meaningful and relevant functional mathematics course our view is that they are more likely to achieve level 2, because they have a smaller programme of study to follow (50% to 80% of GCSE). Hence they and their teachers will have more time to learn and teach for understanding. Of course, there will need to be 'transition' components (Tomlinson, 92) so that people can upgrade their performance when they are ready to do so.

What is functional mathematics?

We find paragraphs 1.1 to 1.9 of the Smith report, which outline all the different facets of mathematics, very helpful when considering what mathematics should be included in any particular pathway and, in particular, what mathematics should be in the compulsory core.

Annex C of the Tomlinson report gives a brief outline of what the content might be. It refers to 'end-users' and preparation for 'adult life – this should include financial literacy alongside the application of mathematics in a variety of other real world contexts'. This needs to be interpreted in the light of the report *Mathematics Skills in the Workplace* (referred to in Smith 1.8), which defines the 'mathematical literacy' needed in the workplace. This mathematical literacy is much more than the ability to carry out and understand calculations and we hope that a functional mathematics course would help to prepare young people to meet the demands of the workplace by developing skills such as complex modelling, interpreting different representations of data, extrapolating, monitoring and communicating. We maintain that, if a functional mathematics course concentrates on the ability to carry out calculations, then the higher-order skills associated with mathematical literacy will remain beyond the grasp of many young people. Furthermore, in order to be able to use and apply mathematical knowledge and skills and be 'mathematically literate', young people need to have confidence

in their own ability. This confidence does not develop automatically. Teachers have to pay attention to it, by finding ways of capturing the interest of their students and hence motivating them to work on the knowledge and skills that are to be taught. And then teachers need to help students to become aware of how different ideas and topics link together and also of how they learn.

In brief, it is *how* students are taught mathematics rather than *what* they are taught that is the key to helping young people develop into adults who are confident about and competent at mathematics. Experience of teaching young people in this age group suggests that this confidence helps them to adapt to future mathematical needs.

GCSE Mathematics

The problem with the current KS4 curriculum is that it is designed to serve the needs of too many different learners. The Foundation programme of study, which is more or less identical to the KS3 programme of study, is not appropriate for learners who are unlikely to achieve a level 2 qualification. As for the Intermediate GCSE, Smith points out in paragraph 4.19 that employers are often less than happy about the mathematical abilities of recruits with grade C in GCSE mathematics. Higher GCSE neither challenges those who want to go on to a level 3 qualification, nor provides them with the necessary knowledge and problem-solving skills. The new pathways models offered by Tomlinson and Smith provide us with the opportunity to define different mathematics courses to suit different learners and it will not be possible to do this if the current KS4 curriculum and the associated assessment through GCSE is maintained.

Smith makes a number of suggestions for immediate consideration in connection with the current GCSE mathematics: two tiers rather than three (4.1); a double award that could include more problem solving (4.2); the role of coursework (4.3); whether or not data handling should be included within GCSE mathematics (4.4); and an extension curriculum (4.5). While we support positive action on all five of these suggestions, we would not want to see too much time and energy being devoted to changing GCSE mathematics in the short term, when a more appropriate and effective model might be to scrap GCSE altogether.

The core: CKSA

We note that recommendation 6 of Tomlinson proposes that the core consist of seven components and we assume that these will form a coherent whole. We strongly support Tomlinson's recommendation 8 that the three broad strands of common knowledge, skills and attributes (CKSA) outlined in paragraphs 73 to 75 should be integrated into and delivered within all 14-19 programmes. We suggest that the following skills and attributes are particularly relevant to mathematics, and that opportunities for students to develop these need to be built into any mathematics course, including the functional mathematics course.
To be reflective and effective learners, students needs to

- organise and regulate their own learning
- identify and solve problems
- identify, analyse and evaluate relevant information, derived from different sources and contexts
- think and use their skills creatively

To be social learners, students need to

- challenge and defend a position
- give and receive support and feedback

To be learners in society and in the wider world, students needs to

- have the skills and attributes necessary for active citizenship and the workplace

The core: extended project

We believe that the extended project provides learners with a good opportunity to demonstrate their mathematical and ICT skills and we are disappointed that mathematical skills are not mentioned in paragraph 71 of the Tomlinson report.

Challenging the more able

We share ACME's concern that the Tomlinson structure does not foster the appropriate means for challenging able students of mathematics.

We also share their concern that, in spite of the well-publicised view of the mathematics education world that acceleration is not an appropriate way of extending more able mathematics students, the notion of acceleration in mathematics still appears to be advocated (paragraphs 240-241 and the 'case study' of Greg on page 55 of the Annex).We hope that this concern will be considered carefully in future planning.

We, like ACME, prefer the notion of an extension pathway, which would at all stages challenge learners to solve non-routine problems and develop their ability to think mathematically (Smith, paragraph 4.21 and recommendation 4.5). This pathway would lead eventually to units within the Advanced Diploma equivalent to the current A2 Further Mathematics and an AEA style of teaching and assessment (Smith, recommendation 4.10). ACME believes there are a number of features in the current proposals which would appear to rule out this approach, and we agree with ACME that these need to be re-examined (ACME's response to the Tomlinson report, Section 3, paragraph iv and Section 4, paragraph ii. This response is available at www.acme-uk.org.)

We agree with ACME that there is a need for further discussion about whether there should be functional mathematics at level 3 and support their vision that what is needed is a 'range of pathways, at least one of which should lead on directly from the level 2 core' (ACME, Section 1, paragraph vii).

Assessment

We support Tomlinson recommendation 21 concerning the assessment of functional mathematics. We particularly welcome assessment based on a mastery model, which is available to be taken when a young person is ready to be assessed. The report says little about adult learners and we assume that these core qualifications in mathematics, literacy and communication and ICT would be available to the whole population and not just to those in education or training between the ages of 14 and 19.

When these tests are developed, we would want best use to be made of e-assessment, with assessment not exclusively based on multi-choice answers. We would also want only one source for these tests. The current situation, where examination boards compete for candidates, actually drives standards down, because candidates choose the option they consider to be easiest.

We, like ACME, welcome the proposed reduction in external assessment and endorse what they say about this in Section 3, paragraph ii. But we do believe that peer moderation can help

teachers to understand more about how young people can be helped to learn mathematics. Teachers, who were involved in cluster moderation when Mode 3 CSEs and GCSEs existed, report what a significant influence this had on their professional development. We endorse ACME's comment in Section 3, paragraph iii, that there are some aspects of mathematics that need to be assessed other than by timed written tests (Smith recommendation 4.9).

The supply and quality of teachers of mathematics

We have already argued that the role of the teacher is crucial and we share all the concerns outlined in Chapter 2 of the Smith report about the supply of teachers. We particularly endorse recommendation 2.5, which proposes that resources are put into expanding mathematics enhancement programmes for teachers. ATM regularly receives calls for help from teachers who find they have to teach mathematics without any appropriate training.

We also endorse recommendation 2.6, which suggests that TTA explore new certification schemes, whereby teachers may gain qualifications to teach some part of the mathematics curriculum: for example, a qualification to teach functional mathematics might be appropriate.

The flexible pathways recommended by both Smith and Tomlinson, together with more emphasis on teacher assessment are likely to lead to a demand for a larger pool of well-qualified mathematics teachers. We indicated earlier in the section on functional mathematics that the key to improving the mathematical skills of young people is to help them feel confident about their ability to use and apply their knowledge and skills. Achieving this requires skilful teaching rooted in a thorough understanding of mathematics and mathematical thinking. Current research indicates that there are a significant number of secondary teachers of mathematics who have weak subject knowledge and pedagogic flexibility which underlines the need for the support discussed in the next paragraph.

Support for teachers of mathematics

If Tomlinson is to be implemented successfully then teachers will need support with implementing the new pathways model. We endorse what Chapter 5 of the Smith report proposes concerning the need for fully-funded subject-specific CPD for teachers of mathematics. Smith proposes a national centre for excellence together with regional centres providing local support and networking (Smith recommendations 5.4, 6.12, 6.13, 6.14). We are not convinced that this will necessarily be the best model for delivering effective CPD. Hopefully, the regional centres will be able to build on current best practice; for example, as a consequence of the Leadership Incentive Grant (LIG) there has been an increase in meetings, between local groups of schools, of subject staff to share good practice and experience. However, we do see advantages in having a unified national support infrastructure within which different infrastructures can be brought together (Smith recommendations 6.2, 6.4, 6.5, 6.6, 6.7, 6.9, 6.10).

Time scale

Consideration needs to be given to how the recommendations of the Smith and Tomlinson reports can be brought together to form a coherent set of pathways through mathematics for students aged between 14 and 19. In particular, consideration needs to be given to the time scale for all the different changes that are likely to occur. We share the concerns outlines in Section 5 of ACME's response to the Tomlinson report, particularly with respect to a 'quick win' approach to designing the functional core.

Next steps

Like ACME, we are pleased that Tomlinson in Annex C, page 129, enjoins QCA to 'actively seek advice and views from experts and end-users' when constructing pathways. We hope that whoever is successful in tendering for this work will also consult with bodies such as the ATM. We look forward to being involved in future work.

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