FUNCTIONAL MATHEMATICS AND ITS ASSESSMENT

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In this paper we outline our work in the King's College London / Edexcel project, Developing Curriculum Pathways in Mathematics. This is one of two projects funded by the Qualifications and Curriculum Authority (QCA) to develop possible curriculum and assessment structures for post-14 mathematics as a result of the Department for Education and Skills' (DfES) response to the Smith and Tomlinson Reports (Smith, 2004; Tomlinson, 2004). We describe our current curriculum model and our approach to Functional Mathematics and its assessment focusing on National Qualifications Framework (NQF) levels 2.

THE CONTEXT

In response to the Smith Inquiry into Post-14 Mathematics Education (Smith, 2004) and the Tomlinson Review of 14-19 Curriculum and Qualifications Reform (Tomlinson, 2004), the DfES has published two white papers: "14-19 Education and Skills" (DfES, 2005a) and "Skills: Getting on in business, getting on at work" (DfES, 2005b). In these white papers, the government propose a set of new functional mathematics qualifications with the aim that "every young person [should] achieve high standards in the basics of functional … maths" (DfES, 2005a, para.3.13, p.24) and for "2.25 million adults to achieve functional competence in literacy, language and numeracy, and over 3 million adults to achieve their first full Level 2 qualification by 2010" (DfES, 2005b, para.18, p.8). The new qualifications will have "mastery of the basics at its heart" (DfES, 2005c, p.5).

THE CURRENT PROPOSALS

Current government proposals include the following:

Retain GCSEs and A-levels. The General (GCSE) Diploma will require achievement of 5 A*-C grade GCSEs including English and mathematics

Introduction of new specialised diplomas at NQF Levels 1, 2 and 3 with a core functional mathematics component

Skills for Life qualifications, Key Skills qualifications and GCSEs to have same functional core and the curriculum and assessment model should set clear pathways from NQF entry level to level 3

The introduction of a GCSE Mathematics double award [now proposed as two distinct GCSEs rather than one double award]

Passing Functional Mathematics level 2 will be a requirement for achieving a grade C or above in GCSE Mathematics.

TIMELINE

The timetable for the introduction of Functional Mathematics qualifications is as follows [1]:

2006/7:	Small-scale trialling of Functional Mathematics
2007/8 & 2008/9:	Full National Pilot of Functional Mathematics curriculum
2009/10:	Functional Maths available as stand alone qualification
2010/11:	Revised Mathematics GCSE including Functional Maths available

THE PROJECT

Developing Curriculum Pathways in Mathematics has been funded for 18 months from January 2005 [2]. A curriculum and assessment model was produced in September 2005 following a consultation process with stakeholders. This model had the following features:

> Functional Mathematics at all levels as stand alone qualifications. For some, mainly post-16, students, Functional Mathematics will be the only mathematics they will do. Hence Functional Mathematics qualifications need to be independent of others and highly regarded, both as courses and qualifications by students, teachers and user communities.
>
> Functional Mathematics level 2 pass / fail hurdle to grade CC
>
> Double award GCSE only, no Single award to avoid a repeat of CSE [3]
>
> GCSE to be a two tier award as follows:
>
> Foundation tier GG-CC
>
> Higher tier DD-A*A*

See Appendix 1 for a diagrammatic outline of this model.

The project team is currently working up a model of curriculum and assessment in sufficient detail for the small scale trialling beginning in 2006/7.

FUNCTIONAL MATHEMATICS: A MODELLING APPROACH

QCA define Functional Mathematics as follows:

> Each individual has sufficient understanding of a range of mathematical concepts and is able to know how and when to use them. For example, they will have the confidence and capability to use maths to solve problems embedded in increasingly complex settings and to use a range of tools, including ICT as appropriate.
>
> In life and work, each individual will develop the analytical and reasoning skills to draw conclusions, justify how they are reached and identify errors or inconsistencies. They will also be able to validate and interpret results, to judge the limits of their validity and use them effectively and efficiently. [4]

Drawing on the Advisory Committee on Mathematics Education (ACME) (2005) principles, we have interpreted the QCA definition by developing the following criteria for the Functional Mathematics qualifications:

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relevance
thinking skills
conceptual understanding
use of technology
mastery
research-base
improving classroom practice
improving take-up of mathematics
student independence

We have adopted a modelling approach to functional mathematics similar to the PISA definition of mathematical literacy (OECD, 2004) and the use of mathematics within Free Standing Mathematics Qualifications (FSMQs). Functionality involves using mathematics for a purpose, whether it be solving a problem, communicating information or simply understanding a situation. At the heart of functional mathematics, is the process of making and using models, often involving the sophisticated use of elementary mathematics. Models are built for a purpose: to understand, control, predict and/or communicate the behaviour of a system that is of interest to the person making the model. Mathematical modelling can be seen as having two distinct but interrelated aspects: *exploration*, or learning about a model that some else has made by exploring it, and *expression*, the building a model in which learners can express their own understanding of a situation (Bliss, 1994).

STANDARDS FOR FUNCTIONAL MATHEMATICS

The standards we have developed reflect this modelling approach. We aimed for a simple and brief description with the following strands:

Making mathematical sense of models and situations

Exploring and tackling models and situations mathematically

Communicating, explaining, reasoning and evaluating.

In order to avoid a focus on fragmented and routine skills rather than the modelling approach described above, we produced a short set of key concepts informed by the GAIM levels (Brown, 1992). In particular, we felt that the standards should encourage the use of calculators and approximation / estimation skills over pencil and paper calculation methods. This approach was relatively successful in that the QCA standards reflected this simplicity, although, as the following comparison of the Level 2 Standards for Quantity demonstrates, the KCL / Edexcel standards are more clearly levelled than the QCA standards:

KLC / Edexcel Standards for Quantity

Mental calculation involving addition, subtraction, multiplication and division of one significant figure approximations

Using standard form

Using and interpreting ratio and rate

Using measures, measuring tools, scales and conversions

QCA Standards for Quantity [5]

Different representations of numbers including ratios & powers

Mental & written calculations & use of a calculator

Estimation & approximation

Measuring scales, conversions including currency & accuracy of measures

A further recommendation, following the ACME (2005) principle that Functional Mathematics should focus on the use of simple mathematics to model complex situations, was that Level 2 should involve mastery of concepts at National Curriculum Level 5. However, the QCA standards cover concepts up to National Curriculum Level 6.

ASSESSMENT OF FUNCTIONAL MATHEMATICS

Our recommendation is that the assessment should consist of both short answer questions and longer, more sustained tasks with calculators and other ICT tools (e.g., spreadsheets) integrated. There should be a choice of portfolio or examination (dependent on learners and educational setting). The assessment should be delivered on-screen as technology allows.

Functional Mathematics must be challenging at the appropriate level and yet require a high standard of mastery for a pass. It must also be sufficiently broad in scope in terms of content, process and context of application to satisfy all groups of students and potential employers. To maximise validity, the assessment should be involve authentic mathematical activity in functional ways. In addition to financial mathematics and other applications of number, it must include substantial components of ICT, handling data, and some applications of shape and space e.g. use of plans, computer designs, maps etc. Developing such assessments within the timeframe allowed is a challenging task.

During the session we presented several assessment items using spreadsheets to illustrate our approach.

Comments on our approach or suggestions for assessment items are welcomed. Please contact the team via e-mail at: jeremy.hodgen@kcl.ac.uk

NOTES

1. See DfES (2005c, p.29) for a more detailed timetable.

2. The team members from Edexcel are Jeffrey Goodwin (Programme Director), Graham Cumming and Kate Halliwell.

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3. This recommendation was not adopted. Ruth Kelly, Secretary of State for Education, announced on 8th March 2006 that there will be two separate GCSEs including a Further Mathematics GCSE for the most able students.

4. http://www.qca.org.uk/11-19reform

5. QCA Functional Mathematics standards are available at http://www.qca.org.uk/11-19reform.

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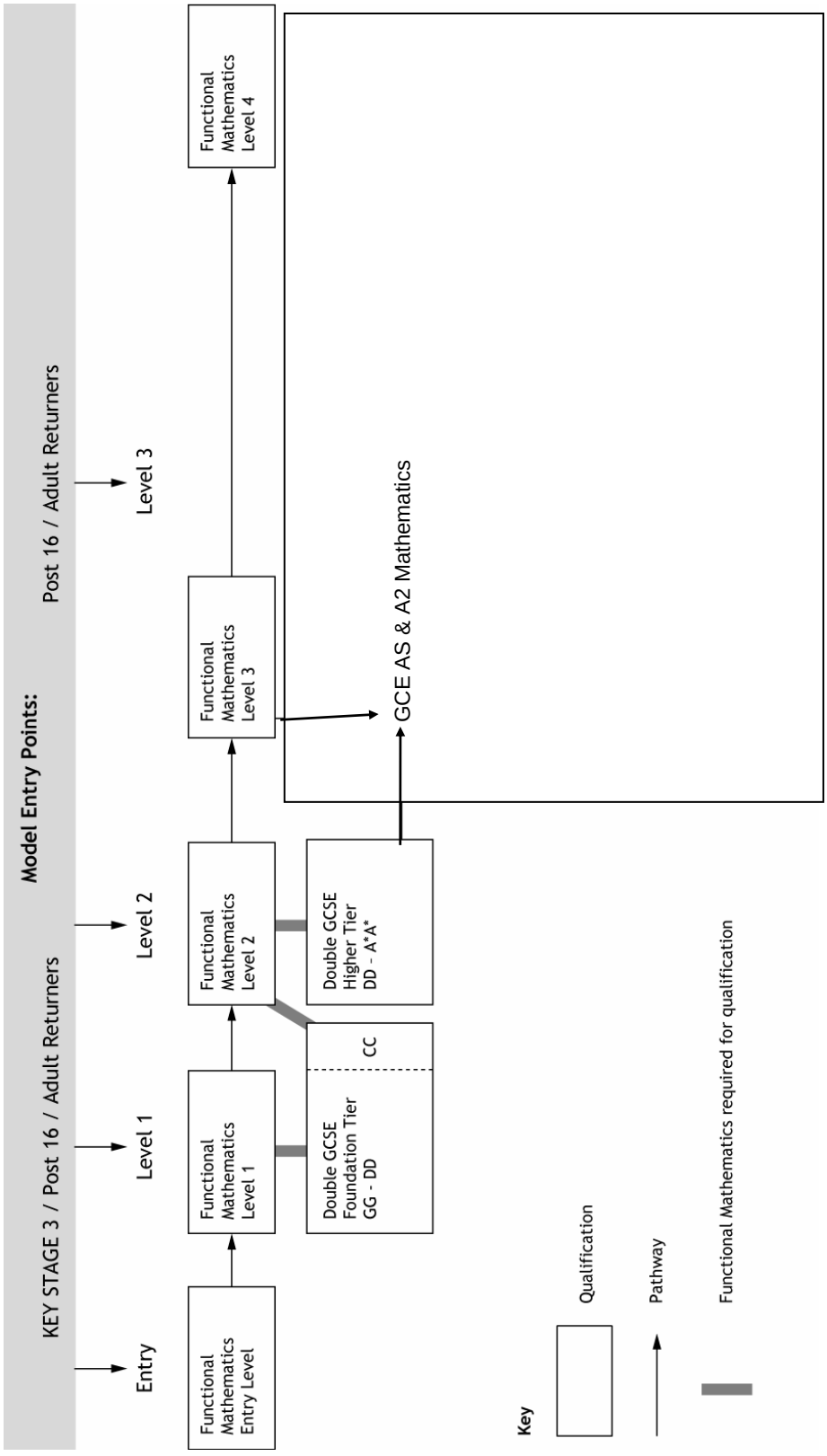
APPENDIX 1: THE RECOMMENDED MODEL OF CURRICULUM AND ASSESSMENT PATHWAYS



See note [3]. NB This diagram does not show AS and A2 proposals.