

A new approach to mathematical and data education

HoDoMS – 19th April 2024

Professor Andrew Noyes



Structure of this talk

- About the Mathematical Futures Programme
- Mathematical and Data Education (MDE)
- MDE pathways
- MDE across disciplines
- Questions and discussion

Core questions

- What mathematical competencies will be needed for citizens and society to thrive in the future?
- How should education systems develop these mathematical competencies?
- What changes can be put in place to move towards that future?

Why is change needed (1)?

Because the world has changed

Mathematical and data sciences are everywhere.

- Virtually all subjects and disciplines are making increasing use of quantitative thinking and methods, and of digital technologies. High levels of MDE will become a necessity for more and more HE and vocational courses and for employment
- Digital technologies mean that the way we use mathematical and statistical thinking in employment and in our daily lives is changing.
- School mathematics education has not kept pace.

Why is change needed (2)?

Because our present system lets too many down.

- Our education system should equip **all** citizens with the capabilities they need to lead fulfilled lives.
- The present system serves some well, but too many are left behind.
- Low levels of numeracy mean that many people struggle to navigate daily life, from budgeting, to analysing claims made in the media

Numeracy

- 17 million working age people (c. 49% of the labour force) have a level of numeracy equivalent to that of children when they leave primary school.
- Well below other countries. Not improving.
- Entrenched culture that it's OK to be “bad at maths”.
- Strong gender and socio-economic biases.

Why does this happen?

- c. 600,000 pupils take GCSE maths each year. Graded 1 to 9.
- c. 30% get < grade 4 at GCSE and must resit. Resit pass rates c.20%
- c.15% take A level in mathematics
- Very little for the rest (Core Maths, but low take up)
- UK an 'outlier' (Nuffield report).

The Maths Futures Programme - Progress

- Wide consultation.
- Commissioned research, including on developments in other countries. Available on the Royal Society website.
- Discussion paper published in September 2023
- Stakeholder consultation took place during Autumn 2023
- Final report due mid 2024, currently under external review
- Political interventions have changed the picture (e.g. maths to 18 announcement, ABS consultation)

A new approach – Mathematical and Data Education

The nature of the mathematical education that is needed is changing from ‘mathematics’ to a fusion of mathematics, statistics, data science and computer science: - Mathematical and Data Education (MDE)

MDE has three components:

- Foundational and Advanced Mathematics
- General Quantitative Literacy
- Domain Specific Competences.

Foundational and Advanced Mathematics (FAM)

- Foundational mathematics establishes the essentials for life and further learning.
- Advanced mathematics builds capacity for more demanding focused study and the application of mathematics and data science in subsequent learning.

General Quantitative Literacy (GQL)

- The ability to use and apply mathematical concepts and use digital tools to solve real-world quantitative problems.
- Confidence and fluency in general arithmetic and proportional reasoning are its foundations, together with an appreciation of presenting and interpreting data.

Domain-Specific Competencies (DSCs)

- Mathematics and data skills are increasingly used outside of the mathematics classroom, in a job or domain-specific context.
- Learners use and apply mathematical and data skills in a range of other subjects and disciplines.

Core elements of MDE

1. Based on a sound understanding of foundational mathematics
2. Makes broad use of digital technologies.
3. Has GQL for all at its core.
4. Values mathematics as a subject in its own right and encourages the study of advanced mathematics.
5. Provides a series of pathways that meet the different needs of learners.
6. Is an opportunity to develop mathematics across all subject domains.

Pathways 14-19

- The aim - a more expansive and flexible system that provides appropriate routes for all students (c.f. Smith 2004)
- All routes should involve 1) data analysis and statistics, to support GQL, and 2) appropriate computing, especially at the higher levels.
- Might have to work with existing structures, ie GCSE/A level. Arguably better with reformed structure (ie Baccalaureate style).
- Best to think of this across 14 – 19 (cf ABS)
- Will involve both FAM and GQL (in different proportions).
- Core Maths useful model, developed at different levels.

MDE and the wider 14-19 curriculum

- MDE is not just a matter for mathematics departments. It is embedded in many, arguably most, school subjects (especially GQL and DSCs).
- Post 16 (currently):
 - A level specifications
 - GMCs/T levels
 - Core Maths
- In reality, something of an MDE ‘portfolio’ develops

What is needed? (summary of recommendations)

Curriculum and qualifications. Design and implement curriculum changes to integrate data, statistics and computing coherently with or alongside mathematics. Develop an MDE curriculum for all educational stages, including coherent support across school subjects. Develop a 14-19 qualification portfolio to support MDE for all learners, including FAM and GQL strands, together with vocational and technical DSCs.

Teachers: provide major MDE training programmes for teachers across all subjects, both CPD and new teachers, including MDE teaching specialists

Assessment: develop new assessment methods, including use of digital technologies. Develop competency-based assessment that measures mastery of key MDE concepts and skills.

Technologies. Integrate tools and technologies for MDE as appropriate for each stage

Thank you!

<https://royalsociety.org/topics-policy/projects/mathematical-futures/>

andrew.noyes@nottingham.ac.uk

Core Maths

- Introduced 2014. c 12,000 entries pa.
- Equate, more or less, to AS levels. Same UCAS score
- Qualifications vary but all include topics such as statistical analysis, mathematical modelling, financial mathematics, and critical analysis of data.
- They focus on developing problem-solving and decision-making skills, as well as improving mathematical fluency and GQL
- Use real-world data and explore mathematical concepts in authentic contexts that are relevant to everyday life, business, or social issues.