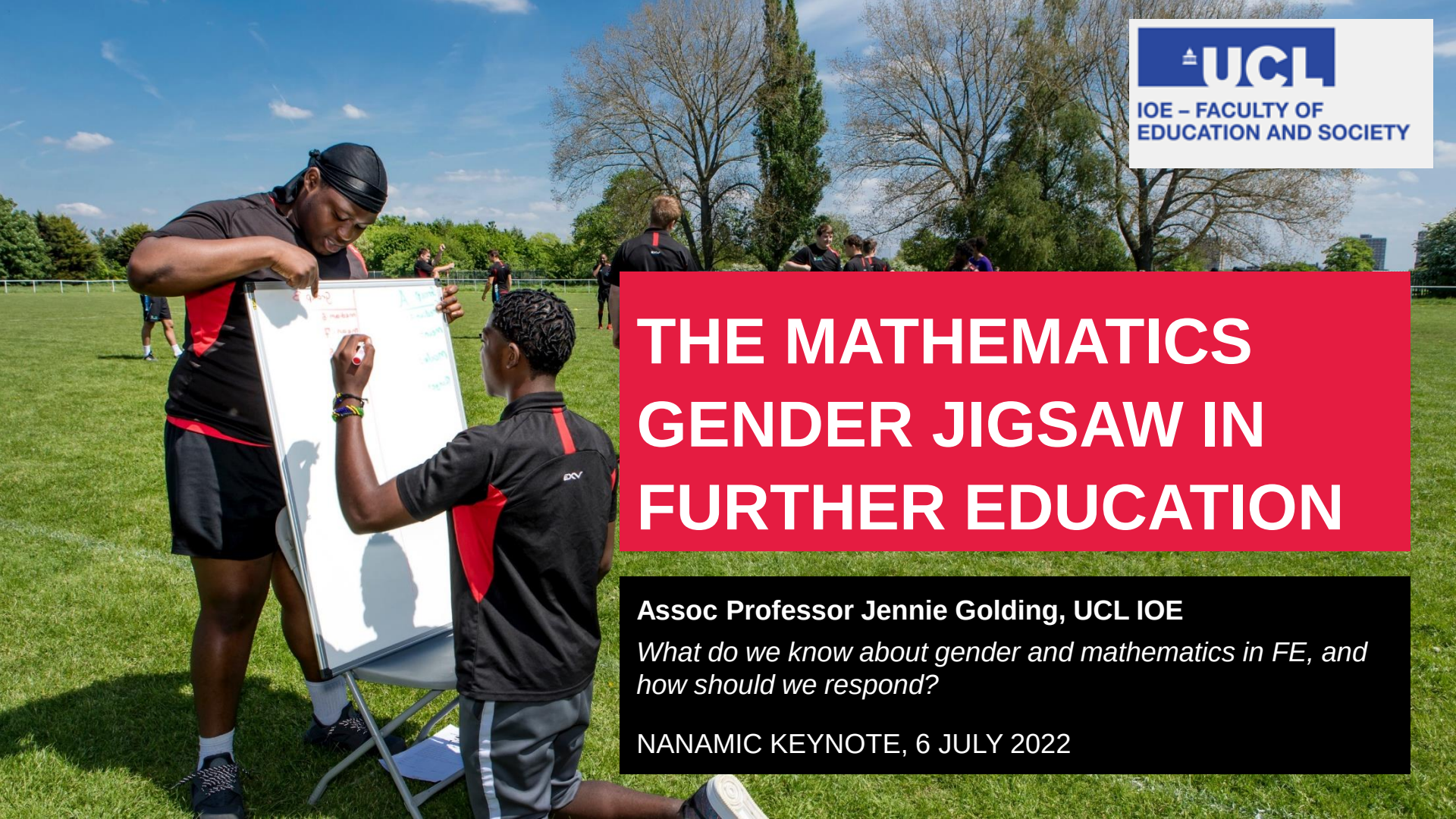

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THE MATHEMATICS GENDER JIGSAW IN FURTHER EDUCATION

Assoc Professor Jennie Golding, UCL IOE

What do we know about gender and mathematics in FE, and how should we respond?

NANAMIC KEYNOTE, 6 JULY 2022

1. About me
2. Gender and mathematics in mainstream education, including in FE
3. Approaches to addressing the identified issues, with a focus on PLAS
4. Questions

- A note on terminology
- Remember also that differential attainment and participation in mathematical and other qualifications by socioeconomic status, as well as for some ethnic and other groups, remains a significant issue for both personal and national thriving (e.g. Ofsted, 2014).

Who am I?

- Mathematician turned teacher turned academic (‘maths ed junkie’)
- 35 years teaching 5 to 18 in schools, and working in teacher development/maths education policy, in England and internationally
- ‘Specialism’ in picking up year 10 or 11 low-attaining students and GCSE retake students
- I now work in classroom-close curriculum enactment research, including with FE-based studies

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02

Gender and mathematics in mainstream education, including in FE

I'll draw on

- my recent research producing *UK mathematics 14-19: the gender jigsaw. A report for the Joint Mathematical Council of the UK (2022).* https://www.jmc.org.uk/output/ and *Gender, self-perception, and mathematics: the 2020 England, Wales and Northern Ireland PISA Field Trial (2021).* https://bsrlm.org.uk/publications/proceedings-of-day-conference/ip41-3/

- my own teaching experience of mathematically low-attaining students,
- the literature around these students, in a variety of contexts,
- their reports when they return to school having transferred to FE College
- the work of FE colleagues in colleges and UCL

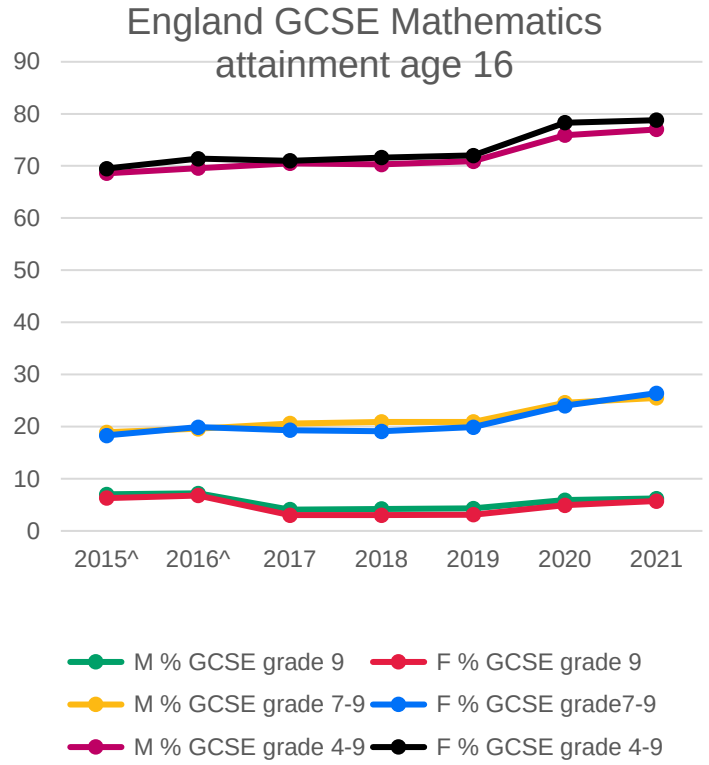
'UK mathematics 14-19: the gender jigsaw' for JMC concluded:

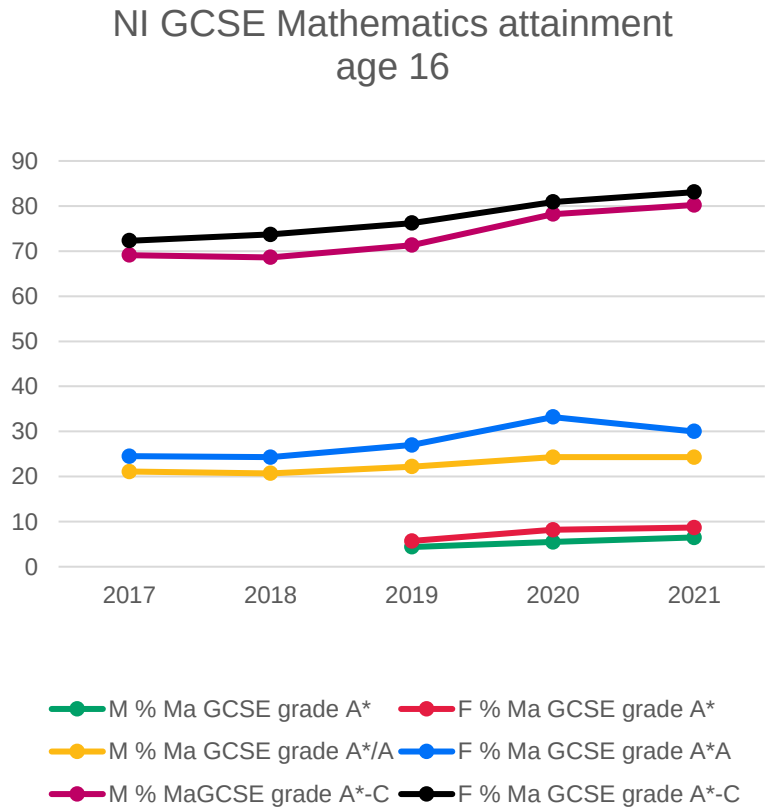
- Broad structures in England, Wales and Northern Ireland have much in common, but curricula and assessments have diverged since 2016. Scotland's provision supports greater local autonomy of enactment, and often a wider curriculum to at least age 17.
- Across the UK, girls enter Mathematics GCSE/N5 and additional mathematics qualifications in comparable numbers with boys at age 16, and they perform at least as well as boys in those qualifications.
- Approaches to assessment during the pandemic have resulted in the award of significantly enhanced grades, especially to girls.
- Each year, around 180,000 older students retake GCSE, especially in England, but the 'standard pass' rate remains low and the mathematical benefit is often questionable.

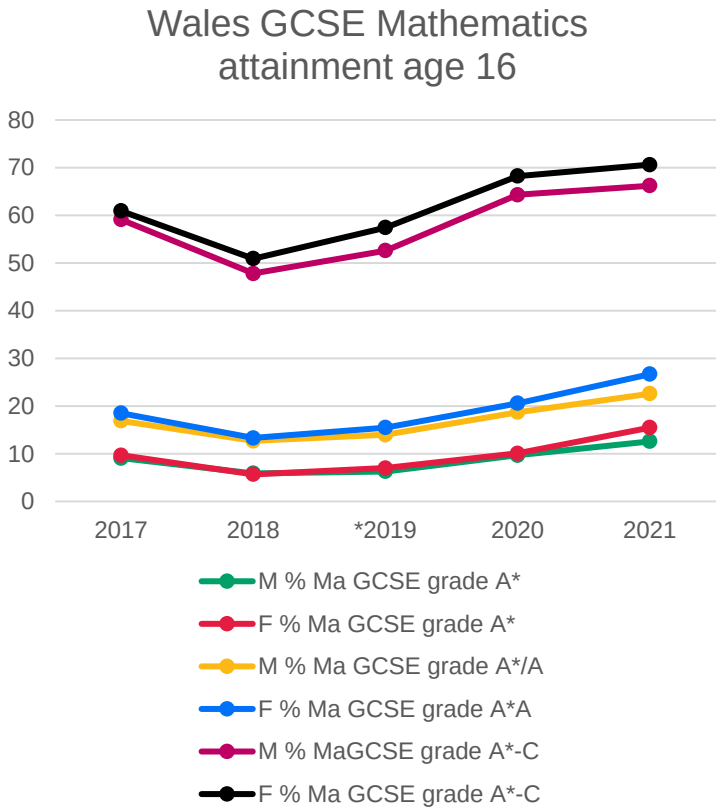
- Significant differential participation in favour of boys is evident in all main advanced school mathematics qualifications in the UK except Core Maths, including in FE colleges, though it is less marked in Northern Ireland. Total advance mathematics entries remaining fairly steady.
- Key issues in 16+ UK education are therefore around provision for previously low-attaining students, gender bias within most advanced school mathematics pathways, and under-participation by previously moderate- or high-attaining students.
- There is comparatively little national information about level 1 or Entry Level course participation and attainment, by gender.

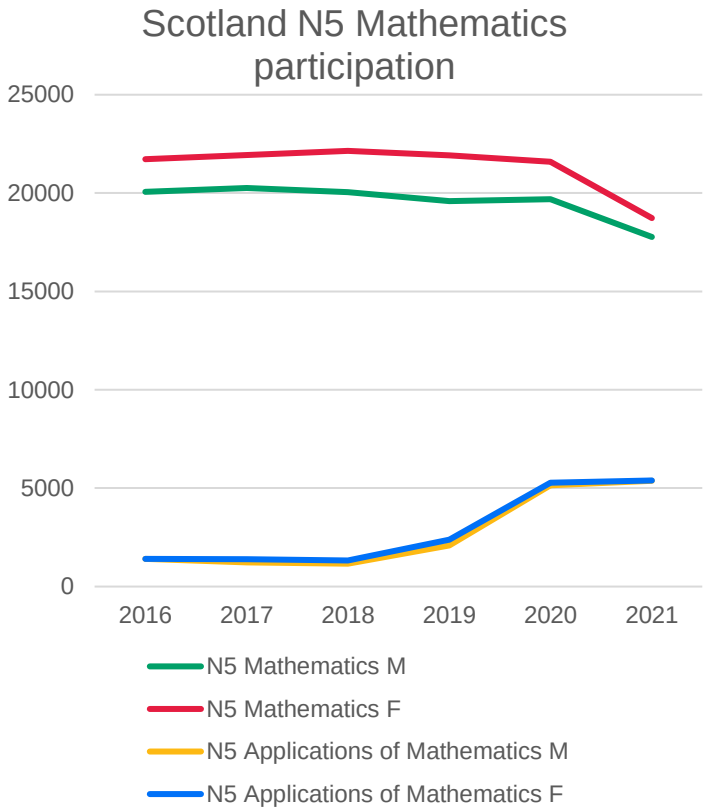
(UK mathematics 14-19: the gender jigsaw Executive Summary)

In graphs:

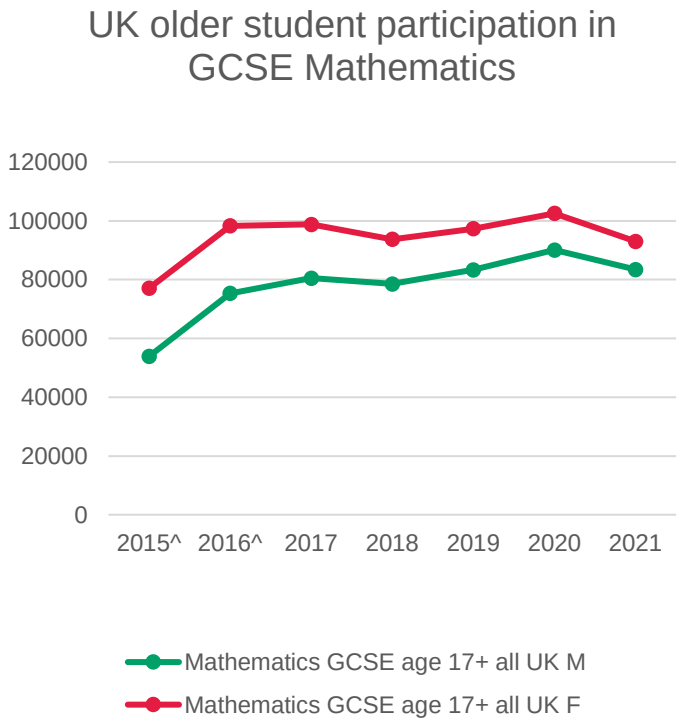

England GCSE Mathematics attainment age 16
90
80
70
60
50
40
30
20
10
0
2015^
2016^
2017
2018
2019
2020
2021
M % GCSE grade 9
F % GCSE grade 9
M % GCSE grade 7-9
F % GCSE grade7-9
M % GCSE grade 4-9
F % GCSE grade 4-9

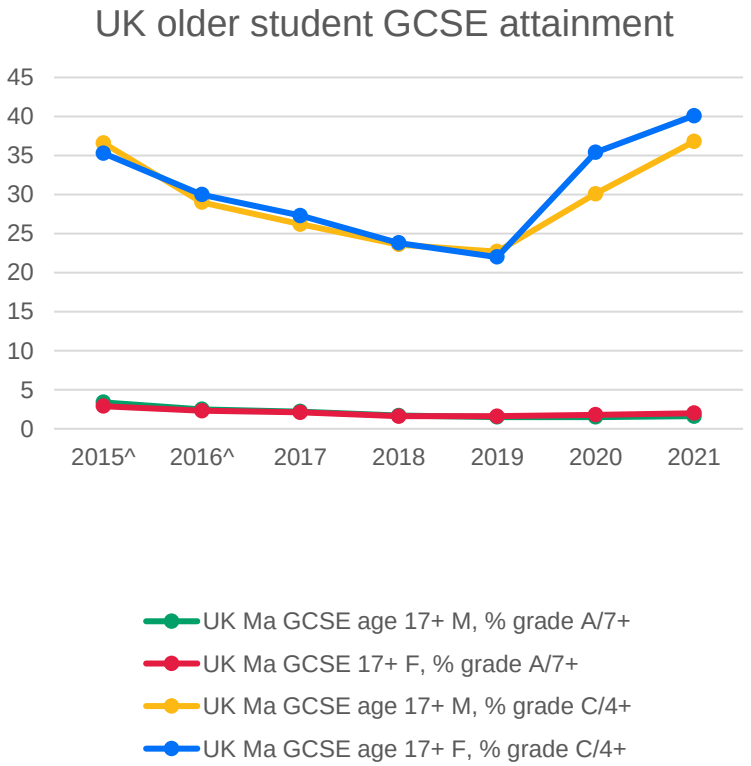

NI GCSE Mathematics attainment age 16
90
80
70
60
50
40
30
20
10
0
2017
2018
2019
2020
2021
M % Ma GCSE grade A*
F % Ma GCSE grade A*
M % Ma GCSE grade A*/A
F % Ma GCSE grade A*A
M % MaGCSE grade A*-C
F % Ma GCSE grade A*-C


Wales GCSE Mathematics attainment age 16
80
70
60
50
40
30
20
10
0
2017
2018
*2019
2020
2021
M % Ma GCSE grade A*
F % Ma GCSE grade A*
M % Ma GCSE grade A*/A
F % Ma GCSE grade A*A
M % MaGCSE grade A*-C
F % Ma GCSE grade A*-C


Scotland N5 Mathematics participation
25000
20000
15000
10000
5000
0
2016
2017
2018
2019
2020
2021
N5 Mathematics M
N5 Mathematics F
N5 Applications of Mathematics M
N5 Applications of Mathematics F

For students over 16





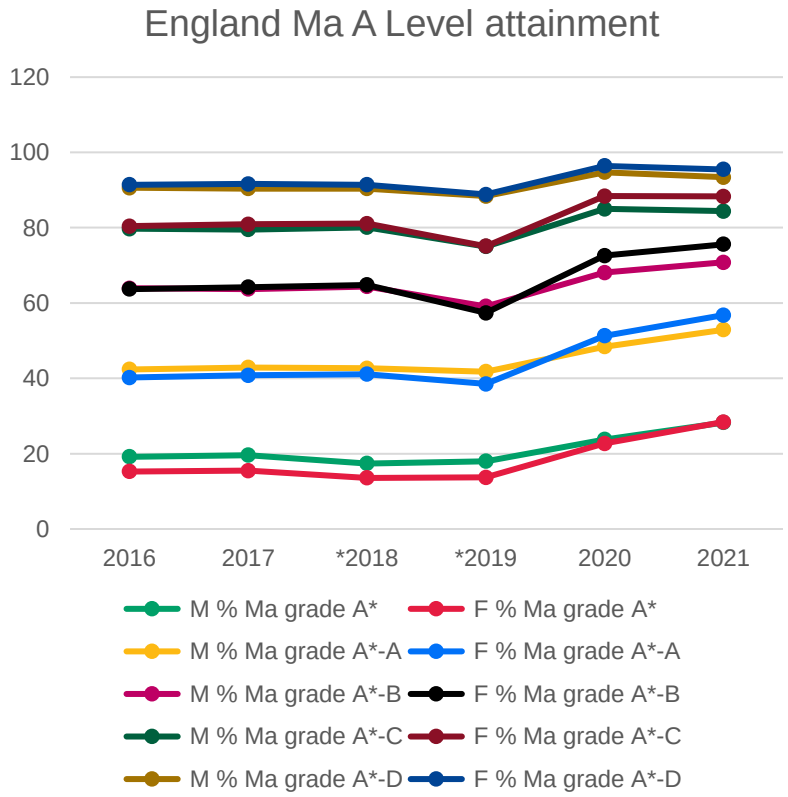
Northern Ireland and Scotland have rather different provision for older students with prior lower attainment, though the participation of older students in Scottish N4/5 and other small or low-level qualifications is difficult to determine from the available data.

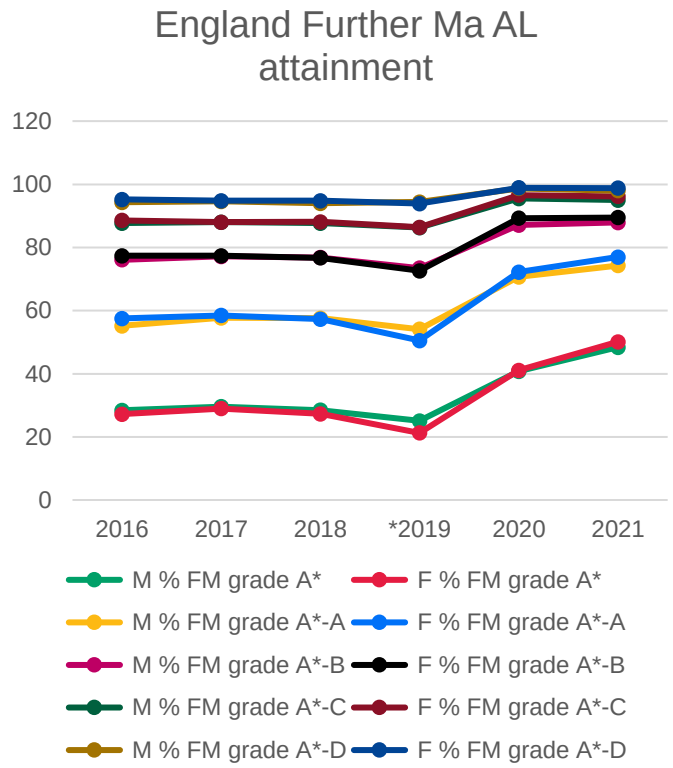
Functional Skills qualifications

- National pass rates for Entry Level qualifications are not easily available, as these are all internally assessed.
- For Functional skills maths at L1,2, national statistics (entry and attainment) by gender are not available, but:

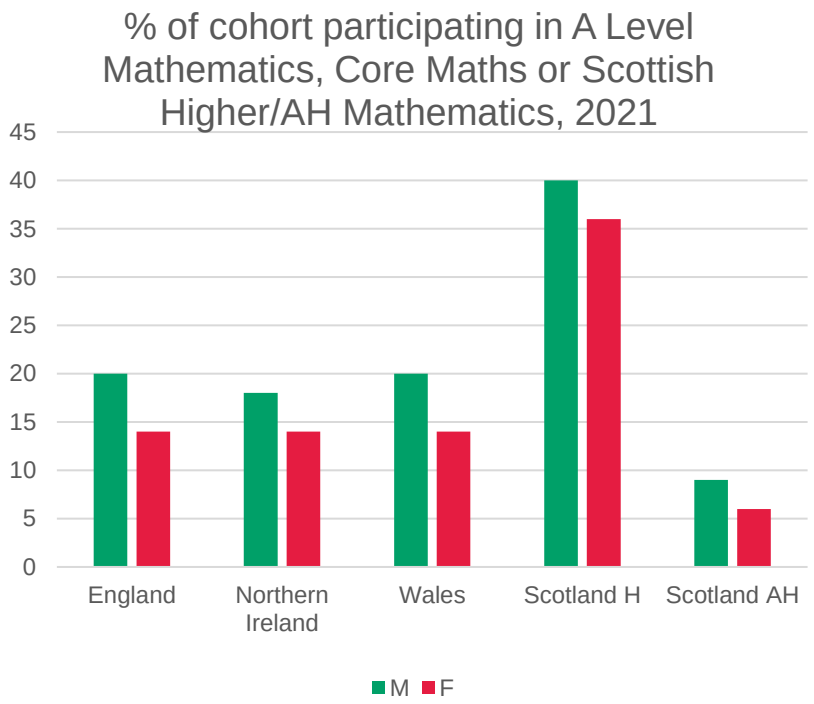
Assessment	First Time Pass Rate	Overall Pass Rate
Maths Level 1	40% (34.4% for FE)	24.1% (20% for FE)
Maths Level 2	42.2% (33.6% for FE)	29.3% (22.4% for FE)

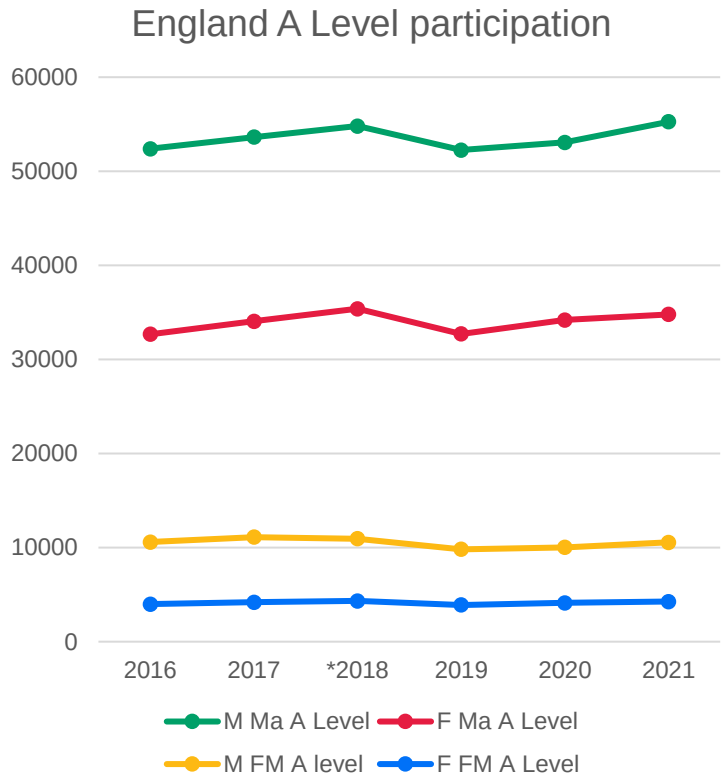
Advanced school mathematics attainment



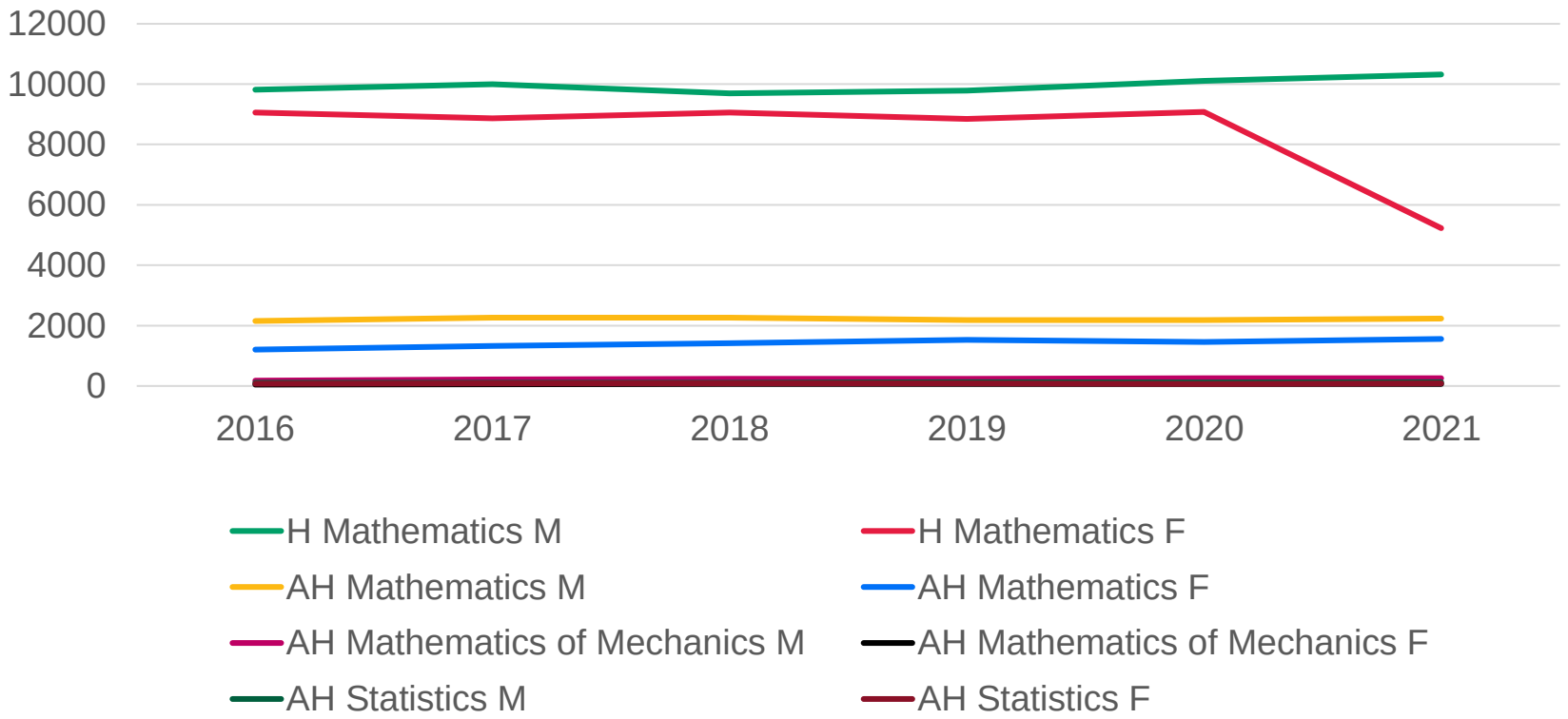


Advanced school mathematics participation

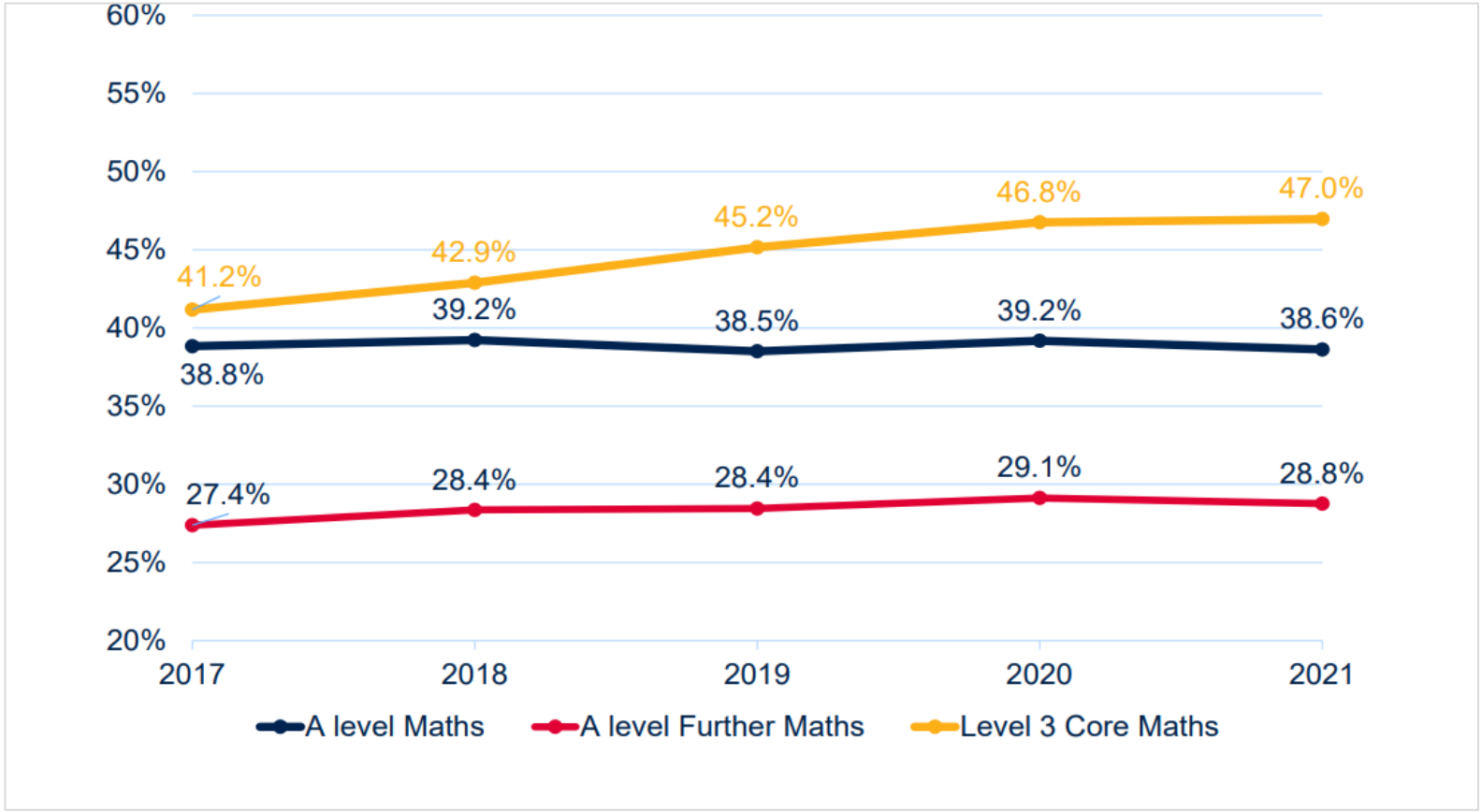




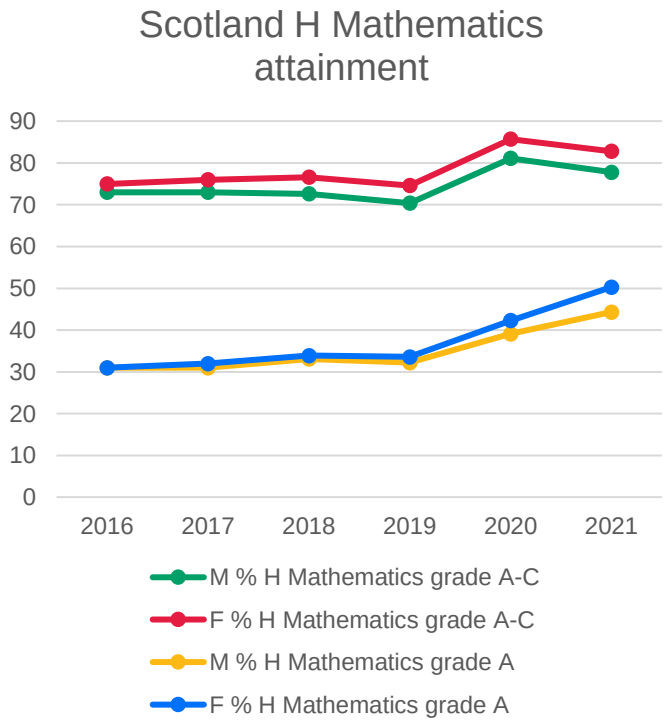
Scotland Higher and Advanced Higher Mathematical Studies participation

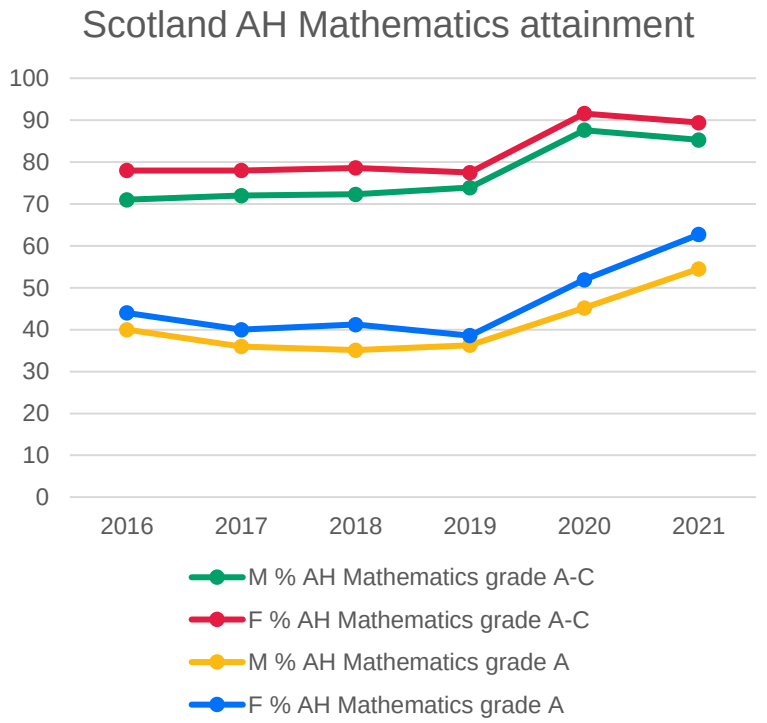


% of female entries for advanced school mathematics qualifications in England, Northern Ireland, Wales



In Scotland:


Scotland H Mathematics attainment
90
80
70
60
50
40
30
20
10
0
2016
2017
2018
2019
2020
2021
M % H Mathematics grade A-C
F % H Mathematics grade A-C
M % H Mathematics grade A
F % H Mathematics grade A


Scotland AH Mathematics attainment
100
90
80
70
60
50
40
30
20
10
0
2016
2017
2018
2019
2020
2021
M % AH Mathematics grade A-C
F % AH Mathematics grade A-C
M % AH Mathematics grade A
F % AH Mathematics grade A

In summary: Mathematics participation and performance in the UK

- F performance at least matches that of M at age 16
- F then participate in GCSE resits in higher numbers. Their success rate is similarly low (except for in the last two years)
- Success rates in entry level, L1 and L2 FS are also low, for both genders.
- F participate in AL Mathematics in EWNI in much lower numbers than do M, but equally successfully.
- The participation gap is less in Scotland, and F often outperform M in Scottish Highers.
- Core Maths is currently achieving comparable participation and attainment from M and F.

Other international evidence: Are these gaps unique to the UK?

- International studies show gendered gaps in academic and occupational mathematics participation are not inevitable, but they are widespread, and often related to comparatively poor mathematics-related affect or unhelpful stereotypes, especially among girls.
- Girls are more likely to value, and be influenced by, pedagogic approaches and supportive interactions that are with a range of others. Participation at this level is enhanced by ambitious, connection-making teaching which embraces appropriate challenge and supports students through that. ***Importantly, we know that also supports long-term confident mathematical functioning across genders.***

International large scale studies to 2022: PISA (mathematics literacy of 15 year olds) and TIMSS (curriculum mathematics at ages 9/10 and 13/14, in England)

- England and Wales show an improving trend in ‘mathematics literacy’ across successive PISA cycles, while Scotland has declined and Northern Ireland has remained broadly stable. Boys have often, but not always, somewhat outperformed girls, but not to the extent they do across the OECD as a whole.
- Accompanying surveys of mathematics-related beliefs and experiences show marked differences by gender, in ways known to be detrimental to girls’ future participation, and these differential reports are remarkably persistent across time and UK country.
- In TIMSS at age 14 (England only, to 2019), students’ reported affect and experiences continue differentially detrimental to girls’ continuing participation.

PISA 2020 Field Trial in EWNI

'We found that *across performance levels* on mathematics items, girls reported their mathematics attainment, enjoyment, interest in pursuing mathematics or encouragement to do so, and perceived competence in mathematics, as well as its perceived utility, significantly less positively than did boys. Irrespective of gender, students reported little exposure to authentic applications of the mathematics studied in school'.

(*Abstract, 'Mathematics and gender: lessons from the PISA 2020 Field Trial in England, Wales and Northern Ireland')*

International studies show that while such findings are not uncommon, they are also not inevitable

Why does it matter?

Relative, as well as absolute, participation and attainment matter because mathematics provides access to careers in the range of STEM and social science fields, and associated personal, economic and social benefits. Women are particularly underrepresented in jobs at the mathematics-intensive technical frontier: in the 20 leading economies, women workers account for 26 percent of workers in data and artificial intelligence, 15 percent of workers in engineering, and 12 percent of workers in cloud computing (WEF 2020). Such concerns underpin recent global focus on participation by gender (e.g. UNESCO 2017, World Bank 2020) but are experienced far from uniformly across the globe. Concerns are reflected in e.g. first year undergraduate numbers in England (Figure 1). However, it is becoming increasingly clear that there is a concern about 'pipelines' into not only the most mathematically demanding courses and careers, but across a much broader range of mathematical functioning, as mathematical demands increase across a wide spectrum of occupations as well as of personal thriving, especially with the proliferation of easily-accessible data

(*UK mathematics 14-19: the gender jigsaw p6)*.

PARTICULAR (ADDITIONAL) ISSUES FOR PLAS

Baggage 1: they have probably ‘failed’ maths multiple times, and have been in the lowest third of mathematics attainers from the start of school.

Baggage 2: they have probably been taught ‘to the test’ and believe GCSE/FS mathematics doesn’t make sense; they believe they ’can’t do maths’

Baggage 3: they probably believe they will look silly to peers if they make mistakes.

*Baggage 4: t*hey believe they are adults now

Baggage 5: they probably resent having maths lessons imposed on them

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03

Approaches to addressing the identified issues

The evidence shows **teaching mathematics for meaning-making** and for connections, including to **realistic uses of mathematics** in across a wide range of contexts, supports the confident participation of all students, but especially girls. That teaching should also **challenge, encourage, support and specifically affirm** the mathematical identity and capabilities of all students. It should offer opportunity for working in a range of both **collaborative and independent, discursive** ways. Developing curricula and pedagogies should also build on **gender-specific preferences** and interests in harnessing digital tools for mathematical purposes. Other small-scale interventions should **target the range of influences** on young people's pathways decisions: their peers, their parents and other influential figures, extra-curricular activities, the resources they use and images and roles they encounter, to promote gender-inclusive messaging. Teachers might also consider single-sex activities on occasion

(*UK mathematics 14-19: the gender jigsaw Executive Summary).*

Curriculum and Assessment

In EWNI, offer, and promote, (preferably two-year) Core Maths for non-specialist mathematicians who have already achieved a level 2 Ma qualification, unless they particularly enjoy pure mathematical ideas and/or want to pursue a maths-intensive area of study or work.

Revisit models of assessment to ensure they promote the mathematical behaviours we value most, including across genders

GCSE Mathematics

Our GCSE Mathematics curriculum and pedagogy in schools (or colleges) are not working well, for most young people. So we need to be more proactive in seeking curriculum and pedagogy models that engage young people and equip them for confident functioning in a world that is already making greater demands on **mathematical, data, financial and digital literacies**. That will benefit all students, but particularly girls.

Meanwhile, for young people coming into FE with low attainment in mathematics, we need to address their ‘baggage’:

Baggage 1: they have probably ‘failed’ maths multiple times, and have been in the lowest third of mathematics attainers from the start of school.

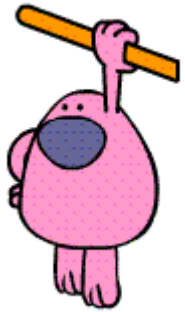
- ***Explicit teaching***
- ***Student talk*:*** whole class, pairs, group activities such as Standards Unit Tasks ‘Improving Learning in Mathematics’ https://mrbartonmaths.com/teachers/rich-tasks/standards-units.html
- ***Formative assessment**** that emphasises effort and progress
- Seek support for 18-month or two-year GCSE retake courses?
- *Acknowledge and actively address exam worries

Baggage 2: they have probably been taught ‘to the test’ and believe GCSE/FS mathematics doesn’t make sense; they believe they ’can’t do maths’

- Be selective and work in depth: it’s important the ideas you do work with make sense to students*
- Draw from your classes what maths they use in their vocational or other courses*: Sam doesn’t need to be using ratios at present but will be convinced of their importance if Ali talks about using them. In large colleges you might be able to teach maths in vocational groups
- ***Explicit teaching*** – for meaning, with ***manipulatives, representations***, peer explanations* (‘who’s got a good way of going about this one?’). Perhaps brain-into-gear activity, focus on one area, build experience individually, in pairs or as a group, include GCSE paper questions and problem solving questions (e.g. https://www.resourceaholic.com/p/problem-solving.html)
- Expose and affirm ***progress and specific successes****
- Maths comes with a speed limit.

Baggage 3: they probably believe they will look silly to peers if they make mistakes.

- ***Explicit teaching***
- It's OK not to understand; it's not OK to *pretend* to understand
- Students write (and answer) their own questions, perhaps in pairs*
- ***Games**** are used for developing confidence and exposing challenges: Treasure Hunts, Murder Mysteries, board games, starters such as the 24-game*, Countdown*
- ***Feedback*** has to be immediate, targeted, concrete, action oriente and confidence building*.



Baggage 4: They believe they are adults now.

- Make that work for you. ‘Now that you’re in college’: capitalise on that fresh start
- Draw on their experience in their other courses, especially vocational courses*
- Use examples that are quirky: are blonde men dumb?
- Increase your expectations of their ***metacognition**** (monitoring and controlling their thinking): what have you done? how far have you got? Why did you think of that?
- Monitor resources you draw on for authenticity, e.g. https://www.map.mathshell.org/tasks.php, ‘Ponzi’ Pyramid Schemes.

Baggage 5: they probably resent having maths lessons imposed on them

- Acknowledge the issue*
- ***Relationships**** are important, but…. Most low attaining pupils enjoy their mathematics lessons and value their mathematics teacher, even though they report finding mathematics difficult. However, learning to work through struggle and some failure is important.
- Subtle messages about the ***usefulness of maths**** – and talk with your colleagues across the curriculum. Contexts need to be authentic – or presented as puzzles.
- https://www.transum.org/Software/sw/Starter_of_the_day/Starter_November25.asp

In summary, pedagogy at all levels should include

- Explicit teaching for sense-making
- Mathematical talk
- Use of manipulatives and representations
- Metacognition and self-regulation
- Formative assessment
- Feedback
- And structures, including teacher professional development, that support those

04

Questions/discussion

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Key literature

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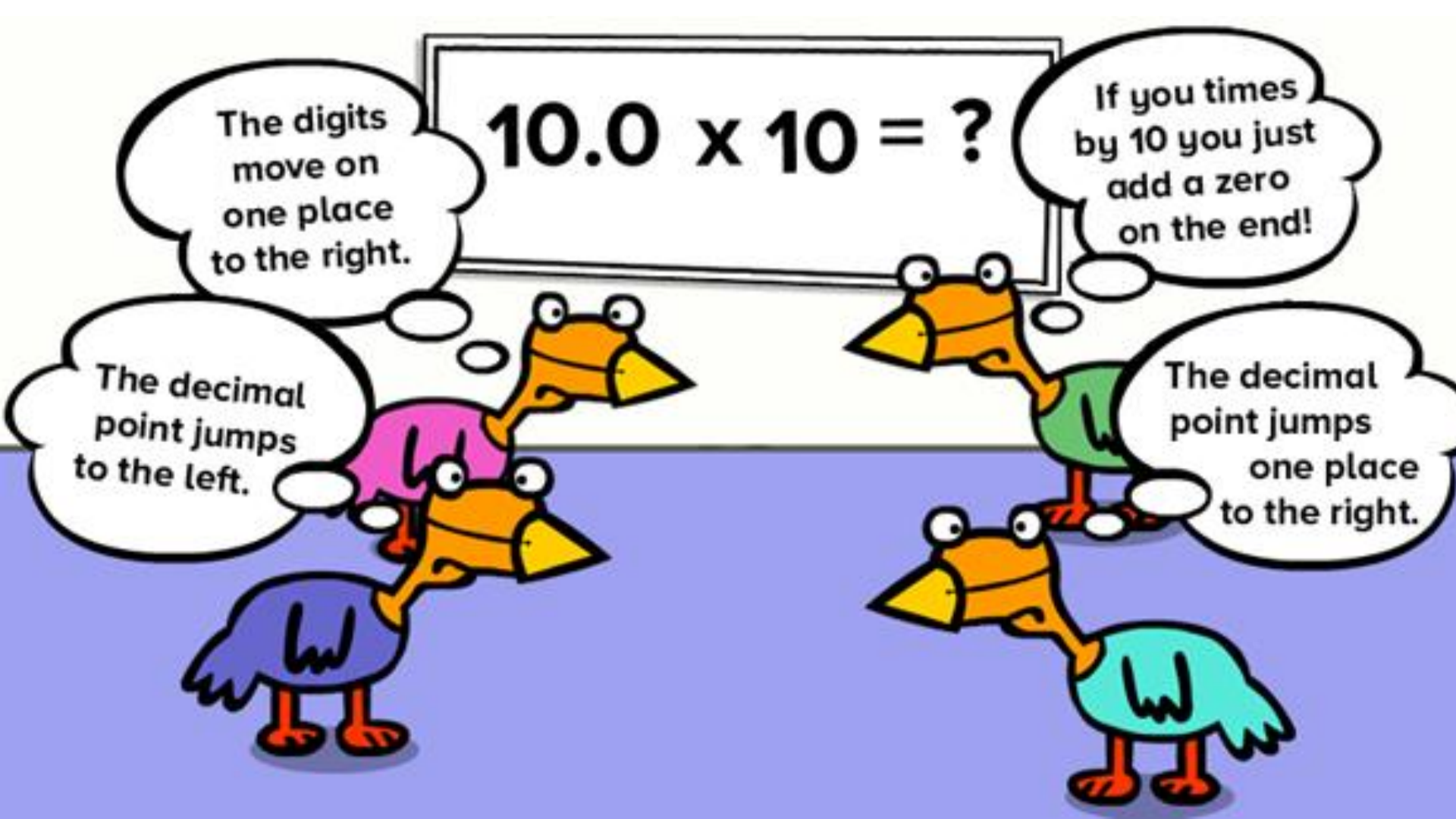
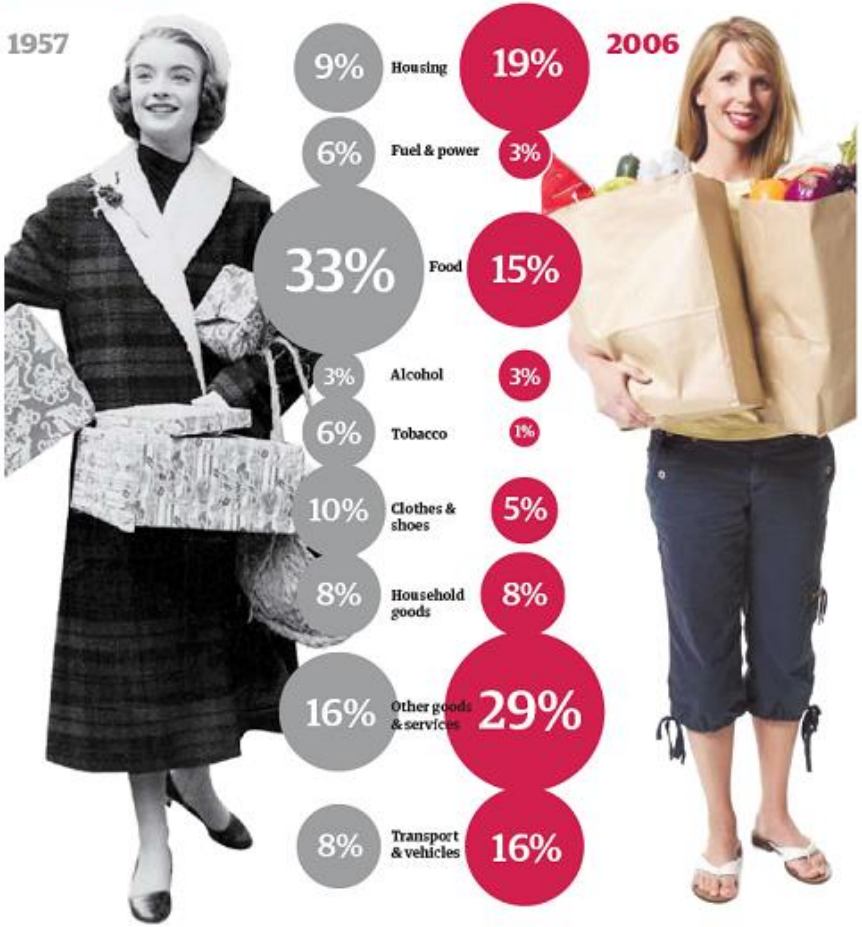

10.0 x 10 = ?
The digits move on one place to the right.
If you times by 10 you just add a zero on the end!
The decimal point jumps to the left.
The decimal point jumps one place to the right.

How our spending has changed

% of household expenditure



Bingo:

Answer the following questions, and cross out the answer on your grid. When you have a straight line of 5 in any direction, say 'Bingo': the winners are the first to say that (with correct answers!)

1	5% of 20
2	20% of 10
3	10% of 30
4	1/5 of 20
5	1/4 of 20
6	15% of 40
7	0.7 of 10
8	1/7 of 56
9	30% of 30
10	5% of 200
11	1/3 of 33
12	40% of 30
13	13% of 100

14	70% of 20
15	30% of 50
16	2/3 of 24
17	25% of 68
18	90% of 20
19	38% of 50
20	4/5 of 25
21	3/4 of 28
22	11% of 200
23	25% of 92
24	12% of 200
25	5/6 of 30

One of the 4 characters below has murdered Mrs X. Analyse the number problems to discover the murderer. Each one has said which of the numerical statements they believe are true or false. The innocent people have only made 1 or 2 errors. The guilty person has made 3 errors.

A) 40% of 500 is 200
B) Half of 390 is 180
C) 0.6 is the same as 6%
D) 0.25 is the same as 2.5
E) 0.6 x 300 = 50
F) $\frac{3}{4}$ x 90 = 60
G) Half of $\frac{8}{10}$ is $\frac{4}{5}$
H) 0.085 is the same as $8\frac{1}{2}$%

Dr Fizz said
A is true
C is true
D is false
H is true

Miss Strict said
E is true
G is false
B is false
D is false

Mrs Encyclpedia said
G is false
C is true
D is true
F is true

Mr Paint said
D is true
C is false
E is true
B is false

Where: The murder took place where these are in ascending order

$$0.109, \frac{1}{10}, 11\%, \frac{90}{1000}, 0.099$$

Nottingham if this order is correct	$\frac{90}{1000}, 0.099, \frac{1}{10}, 0.109, 11\%$
Derby if this order is correct	$0.109, 0.099, \frac{1}{10}, \frac{90}{1000}, 11\%$

Building confidence with number

The 24-game

Using each number once and only once, can you combine the given four numbers using any of +, -, x, ÷?

- 9,6,6,2
- 7,8,5,3
- 3,3,8,8

Using all four numbers 4, 6, 6 and 8, but using each number only once, there are over 60 different ways of getting the answer 24 by adding, subtracting, multiplying and dividing. How many can you find?

Countdown:

Choose a ‘target number’ between 200 and 500

Choose two numbers between 1 and 10

Choose two numbers from 10 to 20

Choose one number from 20 to 30