Two questions

Why am I teaching students a subject they don't want to learn?

- Government policy?
- Poor teaching in primary and lower secondary education?

?

I can teach students to 'do maths' but why can't I teach them to think?

- The curriculum?
- Pressure to "teach to the test"?

2

Two recent projects

1. **Mathematics in Further Education Colleges (MiFEC)**
   Funded by the Nuffield Foundation (2017-2020)

2. **Centres for Excellence in Maths (CfEM)**
   Funded by the Department for Education (2018-2023)

3

We're not very good at maths! (in England)

(e.g. British Academy 2015; Confederation of British Industry 1989, 2015).

Employers report concerns about poor maths skills in England (British Academy 2015; Confederation of British Industry 1989, 2015).

National surveys report low levels of numeracy skills (Moser 1999; BIS 2011; National Numeracy 2014).

International comparisons highlight England's relatively poor numeracy skills (Wheater et al. 2013; Kankaraš et al. 2016).

4

Upper secondary education in England

Age 16

School
GCSE qualifications

Age 16-19

School Sixth Form or Sixth Form College.
A level qualifications (and some vocational)

General Further Education College.
Vocational or pre-vocational qualifications (and A level qualifications).

Employer-based Training.
Apprenticeship

Post-16 mathematics policy in England

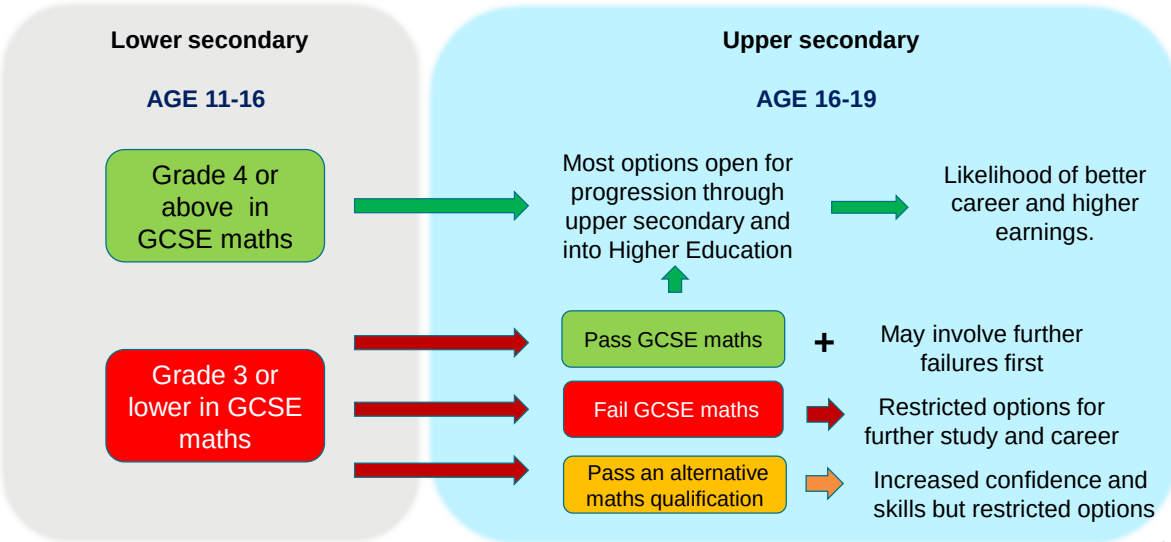
Since September 2014, those who fail to reach a specified minimum standard in GCSE mathematics (grade 4) by age 16 have been required to **continue studying** the subject in post-16 education (upper secondary), with the aim of **retaking** the examination and **achieving grade 4**.

Those with lowest GCSE grades at age 16 (grades 1 and 2) may take a **Functional Skills qualification** first as a 'stepping stone'.

The majority of those required to retake mathematics under this policy follow **vocational pathways** post-16, mostly in Further Education colleges.

7

Pathways and progression



8

The value of GCSE Mathematics

In England, the **General Certificate in Secondary Education** (GCSE) Mathematics is:

- a widely recognised qualification;
- a significant 'gate-keeper' to further study, career entry and progression and therefore has a high 'exchange value' (Williams, 2012).

There is evidence of:

- a link between numeracy and future income (Ananiadou, Jenkins & Wolf, 2004; Parsons & Bynner, 2005; Crawford & Cribb, 2013)
- implications for educational and career progression, and therefore future prosperity (Dolton & Vignoles, 2002).

9

Mathematics in Further Education Colleges project

Findings from a nationwide research project

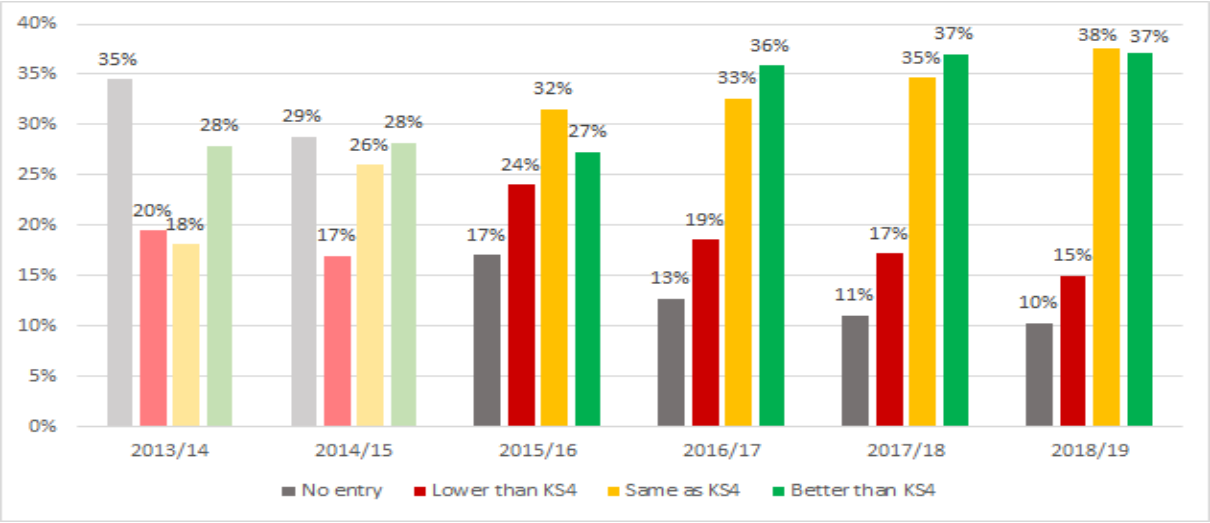
Mathematics in Further Education Colleges project

The MiFEC project aimed to produce evidence-based advice for policymakers, college managers and practitioners on how to improve mathematics education in England's General Further Education colleges. The final report and four interim reports can be found at http://www.nottingham.ac.uk/research/groups/crme/projects/mifec/index.aspx

1. National policy trajectory analysis and literature review.
2. Analysis of student progression over time (using national datasets).
3. Case studies of 32 colleges (238 staff interviews, 62 student focus groups).
4. Mathematics workforce survey.

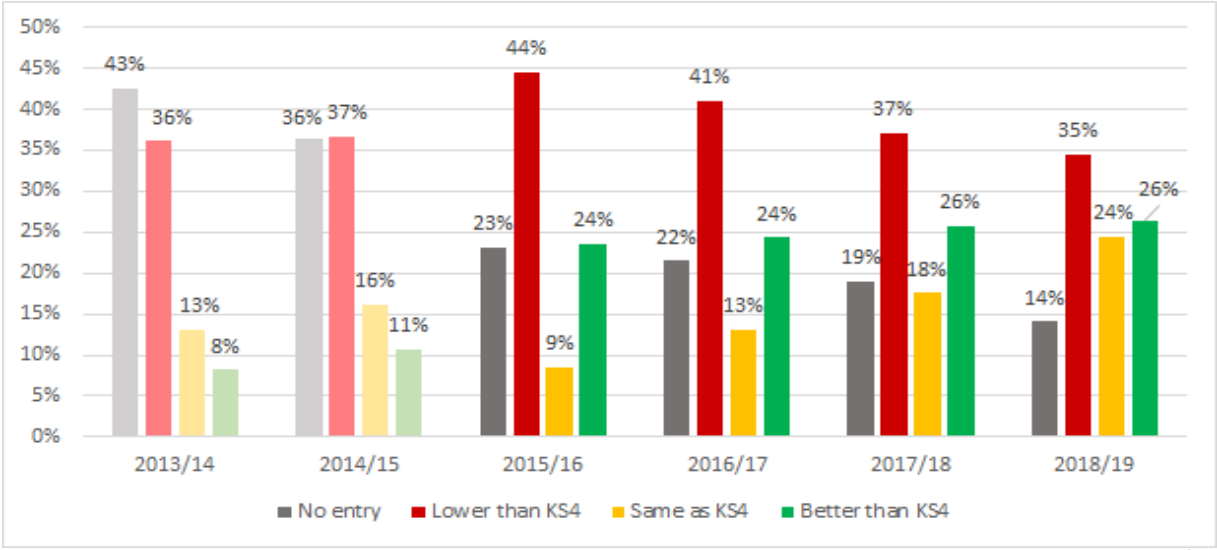
11

Progress of students aged 18 who achieved a Grade 3 or D at school



12

Progress of students aged 18 who achieved a Grade 2 or E at school



13

The black box (behaviour)

Attendance at maths lessons is poor

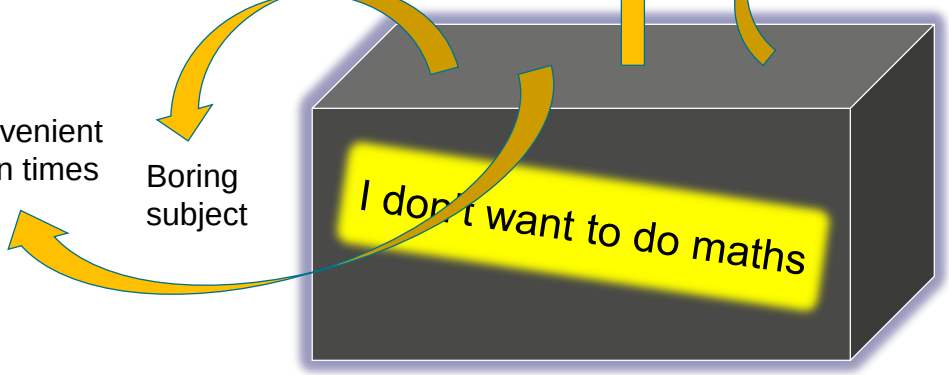
Students do not engage well with maths

Fear of failure

Other demands on time

Inconvenient lesson times

Boring subject

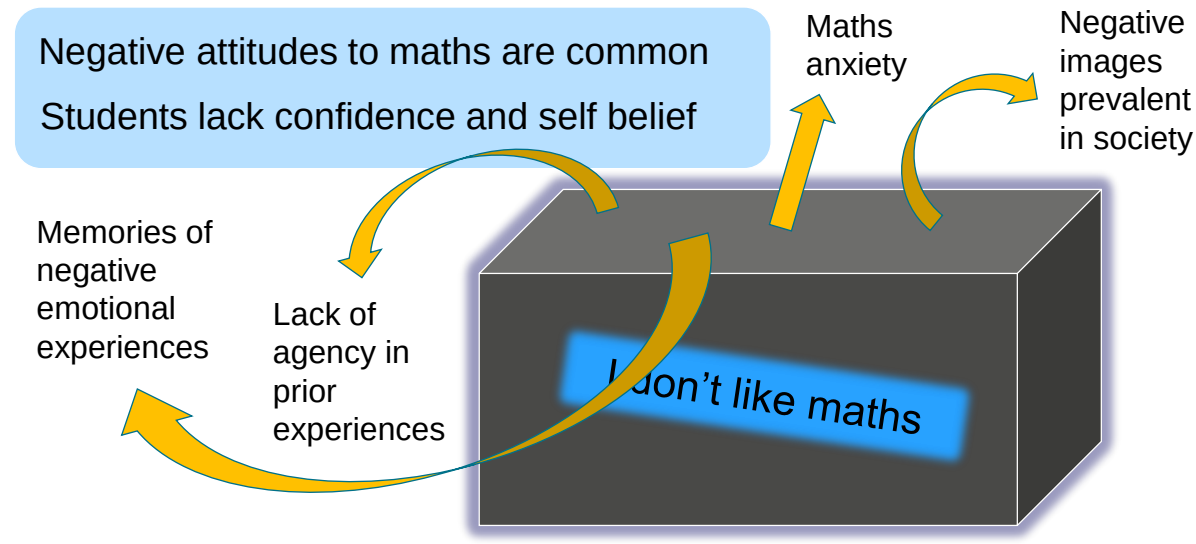


14

The black box (affect)

Negative attitudes to maths are common

Students lack confidence and self belief

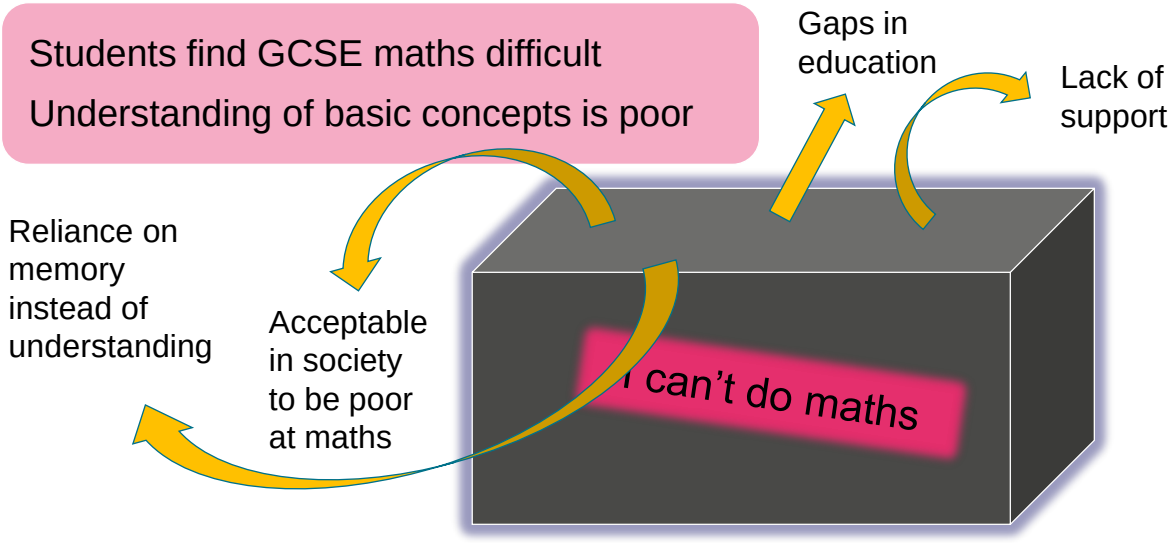


15

The black box (cognition)

Students find GCSE maths difficult

Understanding of basic concepts is poor



16

Transition to vocational education

- Working with real clients
- Working to professional standards
- Working within health and safety guidelines
- Learning skills relevant to personal aspirations and intended employment destinations

Changing **identities** with **work-related values**

17

Negotiating the vocational-academic divide

- Academic subject
- Teacher-focussed approach
- Formal social structure

18

The connected approach

Classroom culture

- A culture that reflects **vocational values**;
- A social structure with **greater agency** for students than usually found in a traditional school mathematics classroom;
- Positive teacher-student **relationships** in which the teachers facilitates learning;
- A **'safe' environment** for students.

Pedagogy

- Understanding of ***signature* pedagogies**;
- Appropriate use of **vocational contexts** (to highlight relevance or develop conceptual understanding);
- Workplace examples that demonstrate **use-value**;
- **Synchronisation** of maths and vocational schemes of work.

19

Centres for Excellence in Maths

A national improvement programme

Centres for Excellence in Maths

Centres for Excellence in Maths (CfEM) is a five-year programme aimed at delivering sustained improvements in maths outcomes for 16–19-year-olds, up to Level 2 (GCSE level), in post-16 settings. The programme is exploring what works for teachers and students, embedding related CPD and good practice, and building networks of maths professionals in colleges. It involves 21 FE colleges, each with a network of partner colleges.

- Teaching for Mastery in FE project (Randomised Control Trials)
- Whole College Approach research project

21

CENTRES FOR EXCELLENCE IN MATHS

Pearson

Teaching for Mastery: Five Key Principles

1. Develop an understanding of mathematical structure
More

2. Value and build on students' prior learning
More

3. Prioritise curriculum coherence and connections
More

4. Develop both understanding and fluency in mathematics
More

5. Develop a collaborative culture in which everyone believes everyone can succeed
More

22

Dialogue in the classroom

A co-construction of knowledge by ‘doing things with others’ (Watkins, 2005).

The form and purpose of student dialogue is shaped by the nature of the **teacher talk** that precedes or accompanies it (Alexander, 2018).

Object-level or meta-level **changes in classroom discourse** may occur (Sfard 2015).

23

Lesson 2: Ratio and fractions

Activity	Time (min)	Description/Prompt
Introduction	5	Introduce the context of buying a baguette to share for lunch. Discuss how the baguette can be shared and remind students of the language of fractions and ratios.
Explore 1	10	Ask the students to work in pairs, matching fraction cards to ratio descriptions of different ways the baguette could be shared.
Explore 2	15	When students are a substantial way through matching ratios and fractions give them some diagram cards to place in the column between the ratio and fraction columns.
Explore 3	15	Once students have completed the ratio–diagram–fraction matches give them a set of description cards to place along the edge of the grid.
Discuss	15	Discuss what completing the ‘Diagram’ column revealed about the relationship between fractions and ratios. Discuss how students adjusted their cards after being given the diagram cards.
Review	20	With the students, explore a common misconception and discuss how fractions and ratios are linked. Describe part–whole and part–part relationships.
Practice question	10	Ask students to answer an exam question and after a few minutes discuss their thinking.

Principles of dialogic teaching

Collective - the classroom is a site of joint learning and enquiry.
Reciprocal - participants listen to each other, share ideas and consider alternative viewpoints.
Supportive - participants feel able to express ideas freely, without risk of embarrassment over 'wrong' answers, and they help each other to reach common understandings.
Cumulative - participants build on their own and each other's contributions and chain them into coherent lines of thinking and understanding.
Purposeful - classroom talk, though open and dialogic, is structured with specific learning goals in view.
(Alexander 2018)

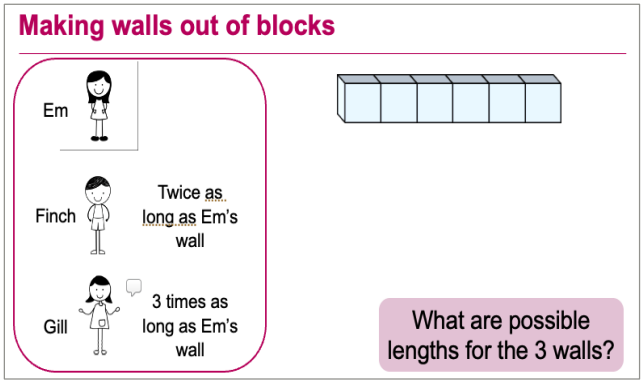
25

Whole class discussion: initial task (Case study A)

What ideas did you have about this question?

Who had a different approach?

Can anyone explain how that works?



- Exposes prior learning so teacher can build on this (KP2).
- Demonstrates that student contributions are valued and helps create a collaborative culture in which everyone believes everyone can succeed (KP5).

Collective – Reciprocal – Supportive – Cumulative

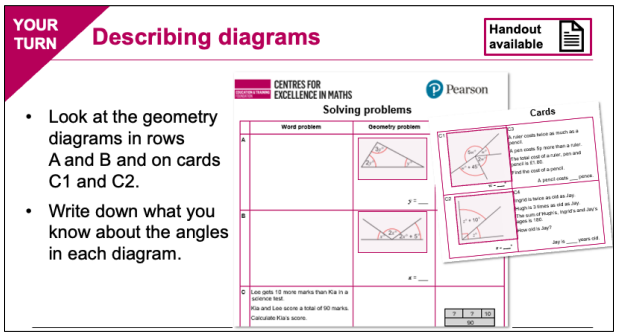
26

Whole class discussion: post-task discussion

How did you get started on this task?

Can you explain what you were thinking?

What other ways did you try?



- Surfaces student thinking so the teacher can build on this (KP2).
- Provides opportunities for students to deepen understanding by considering different methods and representations (KP1, KP4).
- Values student contributions and helps create a collaborative culture (KP5).

Collective – Reciprocal – Supportive

27

Approaches used

Case Study A	Case study B	Case study C
• Invites students to offer ideas and explanations of their thinking. • Follows with questions to probe further into students' thinking. • Asks students for alternative approaches and methods. • Invites students to help each other with explanations.	• Asks students about their methods. • Sometimes asks for more explanation. • Offers own explanations when a student seems stuck. • Spends less time on discussion than lesson plan suggests.	• Asks students for the answers. • Sometimes asks students to explain their methods. • Rarely asks about any alternative approaches or ideas. • Almost always ends by explaining a method themselves.

28

Creating and shaping dialogic spaces

Dialogue about mathematics was shaped by **sequencing** different types of questioning to expand and narrow discussions according to students' responses and needs. Teachers used a combination of:

- **Open** questions about students' ideas;
- **Exploratory** questions to follow up on students' responses and probe more deeply into their thinking;
- **Invitations** to offer further explanation and alternative ideas;
- **Requests** to help explain ideas proposed by other students or build on other students' ideas.

29

A Whole College Approach to Mathematics

Principles from an ongoing programme to improve student attainment in mathematics

Background

The Mathematics in Further Education Colleges project (MiFEC) evidenced broad agreement from a cross-section of staff in England's FE colleges that mathematics is **important** and that students with low attainment should be **improving their mathematics skills**.

There was also evidence that:

- students can receive **inconsistent messages**, explicitly and implicitly, about the need to engage with mathematics;
- combinations of strategic or operational approaches can produce **variations** in students' experiences and sometimes hinder their participation or progress.

31

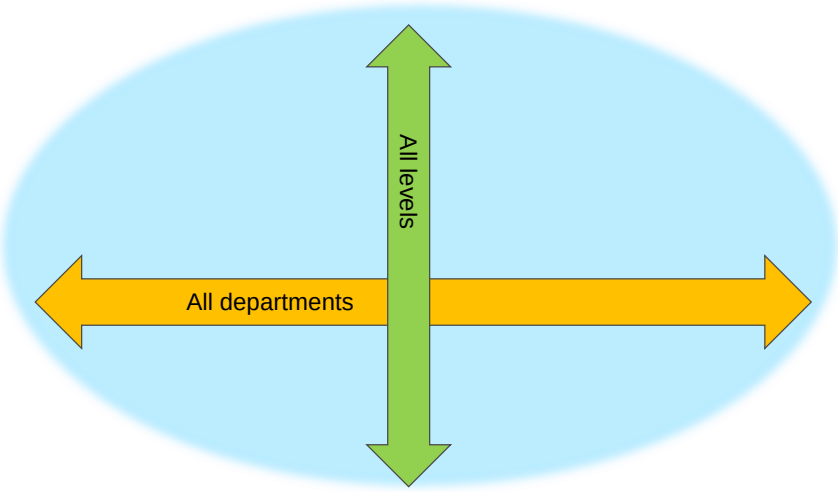
A Whole College Approach

Fragmentation → Coordination → Collaboration → Active participation

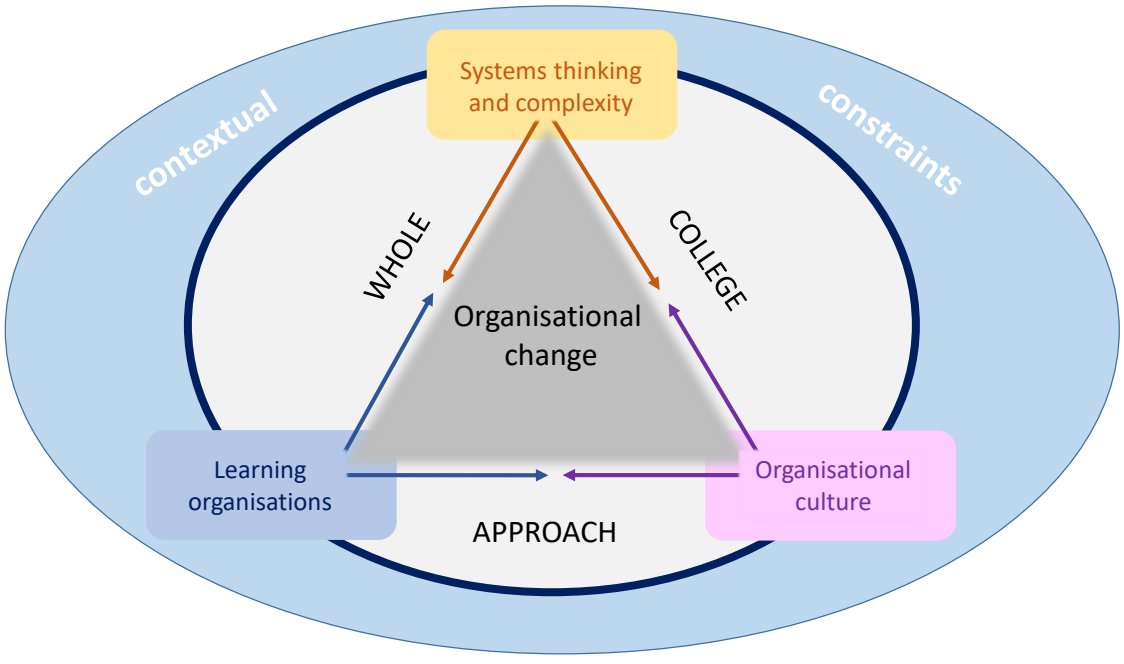
In a Whole College Approach, improving students' mathematics skills becomes a **shared responsibility**, supported by all staff through their active engagement in a **collaborative** effort.

32

Shared responsibility



33



A Whole College Approach

An opportunity to explore, develop and implement a WCA intervention. Participating colleges:

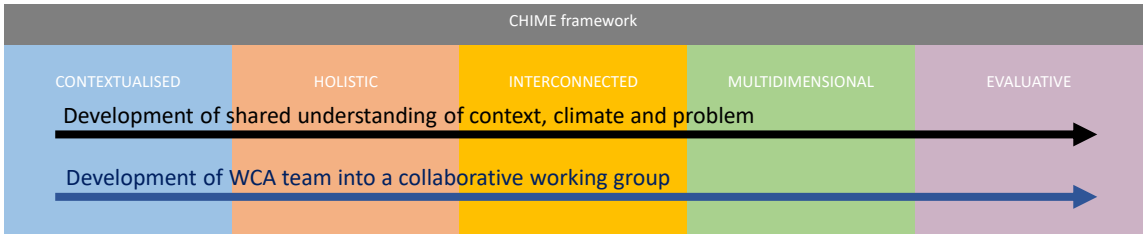
- form a cross-college **WCA team** to meet regularly;
- explore a self-identified **problem** or area for improvement;
- develop a **WCA action plan** to address the problem;
- work with the **resources** and guidance provided by UoN;
- participate in meetings with UoN to **review** progress;
- participate in **research** led by UoN to give feedback on the resources and process.

35

Overview

36

DISCOVERY PHASE		
SA1: context and readiness	SA2: climate	SA3: analysis
To develop: • a shared understanding of the college **context**; • a shared understanding of organisational **readiness** to change; • collaborative ways of working together within an open-minded, inquiring and supportive culture.	To develop: • a shared multidimensional view of the college **climate**; • better understanding of different perspectives and their value in multidimensional analysis; • collaborative ways of working together.	To develop: • a shared understanding of the **problem** and related issues; • a detailed analysis of the problem (using CHIME); • Understanding of key elements, connections, affordances and constraints of systems and culture.



Different perspectives

Through the Discovery Phase, colleges developed a better understanding of the problem and therefore a more appropriate action plan by meeting together and **sharing different perspectives** in open and honest conversations.

However, it should be noted that sometimes there was a need to **'broker' the discussion** with an independent chairperson, especially in situations where attitudes were deeply ingrained or there were initially strongly opposing views.

38

Addressing the problem

Most colleges found that the area or problem they eventually decided to tackle was **not the same** as the one they initially identified.

Colleges reported that by addressing one problem they often found the process they worked through also led to **improvements in other areas**.

Colleges reported that it has been important to consider both **systems and people** in their projects.

39

Common issues

Attendance at mathematics sessions

Increased **communication** about mathematics between maths and vocational teachers has improved communication about other matters such as student attendance and led to better mutual understanding.

Student engagement with mathematics

Colleges have used various approaches to make **curriculum connections** and develop **closer relationships** (e.g. using vocationally-relevant contexts, shared events, coordinated schemes of work, visits to each other's classrooms).

40

There is more to say …

Dalby, D. & Noyes, A. (2022). Developing the mathematics teacher workforce in England's FE colleges: towards a 'communities of practice' strategy. *Research in Post Compulsory Education.* 27(3) pp.413-435.

Dalby, D., & Noyes, A. (2021). Mathematics curriculum waves within vocational education. *Oxford Review of Education*, 1-18.

Dalby, D. (2021). Changing images of mathematics in the transition from school to vocational education. *Adults Learning Mathematics*. 15(1) pp.45-57.

Dalby, D. & Noyes, A. (2018). Mathematics education policy enactment in England's Further Education colleges. *Journal of Vocational Education & Training.* 70(4), 564-580.

Dalby, D. (2017). The professional identity of mathematics teachers in Further Education. *Adults Learning Mathematics*, *12*(1), 7-16.

Dalby, D., & Noyes, A. (2016). Locating mathematics within post-16 vocational education in England. *Journal of Vocational Education & Training*. 68(1), 70-86.

Dalby, D., & Noyes, A. (2015). Connecting mathematics teaching with vocational learning. *Adults Learning Mathematics.10(1), 40-49.*

41