EDUCATION & TRAINING FOUNDATION

CENTRES FOR EXCELLENCE IN MATHS

Pearson

PRINCIPLES AND PRACTICE

MOTIVATING AND ENGAGING STUDENTS IN FURTHER EDUCATION MATHS

Contents

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Introduction

Programme overview

The Centres for Excellence in Maths (CfEM) programme, funded by the Department for Education (DfE), is designed to deliver a step change in maths teaching up to Level 2 in post-16 settings. A range of expert delivery partners and Centres for Excellence across the country are working together to design and develop evidence-based teaching approaches in four themes:

- an adapted mastery approach for the post-16 sector
- contextualisation – relating maths to real-world situations
- motivating and engaging learners
- using technology and data for maths teaching.

Centres for Excellence and delivery partners

The Centres for Excellence are 21 providers in the Further Education (FE) sector selected to drive innovation and improvement in both their institution and beyond. They are each establishing a network of ten or more partners to share practice across the FE sector. **You can see the 21 centres on the ETF website**.

The Education and Training Foundation (ETF), the national workforce development body for the Further Education and Training sector, is managing and leading the programme, working in partnership with a range of expert partners:

- **Association of Colleges (AoC)**
- **Behavioural Insights Team (BIT)**
- **Eedi**
- **Pearson**
- **PET-Xi**
- **touchconsulting**
- **University of Nottingham**
- **White Rose Maths**.

Trials and action research

An important aspect of the programme is to increase the evidence base of what works in maths teaching in the sector. The Centres for Excellence and the University of Nottingham are working together to carry out a range of trials and action research projects looking at aspects of the four themes. The focus of inquiry will change through the course of the programme.

The trials are supported by classroom resources, a professional development programme and collaborative networks. In 2019–20, the national trials are centred on GCSE resit courses, with the key mathematical concepts outlined below ensuring that they are focused on improving attainment between GCSE Maths grades 3 and 4.

Key mathematical concepts

The CfEM programme has focused in on a small number of key mathematical concepts. These concepts aim to provide the maximum potential improvement for students. The University of Nottingham has used anonymised exam data from Pearson Edexcel to identify the concepts that might have the most impact on attainment. Data from diagnostic questions are then used to show teachers where to target their teaching on these key concepts by highlighting common knowledge gaps and misconceptions.

The key mathematical concepts are the same across the four themes:

- working with and understanding number
- multiplicative reasoning
- fractions, decimals and percentages
- basic algebra
- measure (area and volume).

Motivation and Engagement

The Motivation and Engagement theme looks at a diverse range of strategies for developing a positive learning environment.

Handbooks

There is a Handbook for each of the four themes. The Handbooks are evidence-based guides for teachers on current research and good practice. They can be used by any post-16 maths teacher looking for evidence-based approaches to teaching. Each Handbook outlines research for the theme, explains why it is important to maths teaching in the post-16 sector, and exemplifies how you might consider developing your teaching to reflect some of what we know from this research.

How to use the Handbooks

Key principles

Each Handbook is structured around key principles. These key principles have been created to reflect both the crucial points from the research and areas where there is the potential to make the biggest difference to teaching. Developed by the delivery partners and teachers from the Centres for Excellence, these key principles provide focus for each theme and allow consistency across the themes and outputs for the programme. They are not meant to restrict how you apply the themes to your teaching. Instead, they are intended to describe how well-informed approaches might apply in each theme and support you in changing your practice in line with these approaches.

Find out more

There are lots of links between key principles and between the different themes. ‘Find out more’ boxes highlight these links.

Key terms and ideas

The most important terms and ideas in sections are highlighted in separate explanatory boxes.

Further reading

The Further reading sections at the end of the Handbooks give you the opportunity to dig deeper into the research. These references are cited throughout the Handbooks, and particularly important documents can be found through hyperlinks.

Motivation and engagement

What do we mean by motivation and engagement?

Motivation and engagement in education are not the same but are closely interrelated.

- Motivation is a disposition towards learning, based on or affected by students' reasons, beliefs and emotions.[1]
- Engagement is the involvement or participation in learning, which may be triggered by motivating factors.[2]

The sources of motivation may be intrinsic or extrinsic.[3, 4] Motivation is not static and can change depending on context.

- Intrinsic motivation occurs when students become interested in the subject for its own sake.[2]
- Extrinsic motivation arises from external sources such as personal goals, for example, when students need a qualification to progress to further study. When students need the qualification for progression to a personal goal, the qualification has an **exchange value**. If students recognise the skills they are learning as useful for their personal lives or career then there is a **use value** in achieving competence with these skills.

Key terms

Exchange value is when a qualification gains you access to certain courses.[5]

Use value is understanding the need for competent maths skills.[5]

What does the research tell us?

Research shows that students who are motivated persist at tasks for longer, produce higher-quality work and perform better on academic tests.[6, 7, 8]

A number of recent studies have highlighted the issue of poor engagement and low motivation among low-attaining students studying GCSE or Functional Skills maths post-16.[9, 10, 11, 12, 13] The studies identify that poor engagement and motivation may arise from the following:

- Negative prior experiences and failures, which have led to low expectations of success.
  - As previous encounters of GCSE maths have not resulted in students achieving a pass grade, many experience perceptions of failure, which contribute to low motivation and reluctance to re-engage.[13]
- Lack of belonging.
  - Some students will have recently transitioned to college and/or been placed in maths classes that are outside of their vocational classroom settings. This can be intimidating to students, particularly when added to doubts about their performance. Feeling uneasy can reduce willingness to participate as well as cognitive capacity for mathematical processing.[14]
- Anxiety about maths and/or taking a maths exam.
  - Intrusive anxious thoughts reduce cognitive resources, such as working memory, required for mathematical processing.[15]
- Negative cultural attitudes to maths in society and peer pressure.
  - Students often perceive that maths has little personal relevance to them and the subject may not sit comfortably alongside their vocational courses. Generally, students are more motivated to engage when they see the personal relevance of maths to their own lives.

As well as teaching maths, Further Education (FE) teachers face the challenging task of changing students' beliefs about maths and dealing with low self-esteem. This needs a classroom approach that does not just concentrate on the subject matter, but also addresses negative attitudes and emotional responses, such as fear and anxiety, to learning maths.[2]

An exclusive focus on teaching maths concepts and skills is unlikely to lead to improvements in the progress of students who have negative attitudes and emotional responses to learning maths. Integrating strategies that address poor engagement and low motivation alongside a cognitive approach will help students to better engage with curriculum content. In order to support students and help them to make progress, we need to understand the causes of low motivation and engagement so that students can engage more fully with learning.

Strategies to overcome poor engagement and low motivation

The reasons for disengagement are diverse and approaches to re-engagement need to be varied to address students' needs.[10, 13] Strategies to address poor engagement and low motivation are outlined in the table below.

Reasons for poor engagement/low motivation	Strategies to combat them
Negative prior experiences and failures, which have led to low expectations of success	• An emphasis on effort and gains in learning rather than performance goals, to help students develop resilience.[2] • Effective and timely assessment and feedback to make students aware of their progress. • Feedback that emphasises progress rather than achievement.[2] See pp. 14–16
Lack of belonging	• A classroom culture that provides a safe and organised learning environment, where students are not worried about getting answers wrong. • Positive teacher–student relationships that build personal connections, so individual students feel included. • Get students to reflect on aspects of their identity, unrelated to maths, to help them maintain a positive self-image.[14] See pp. 8–9
Anxiety about maths or taking a maths exam	• Timely activities that encourage students to reflect on and re-evaluate their concerns about maths and taking exams.[16] See p. 16
Negative cultural attitudes to maths in society and peer pressure	• Reminders of the vocational, exchange and life values of maths. • Relatable messengers, for example, other students, vocational experts or other role models, used to communicate why maths is useful in a variety of contexts, and how this relates to students' own lives. See pp. 10–11

Key principles

Key principle 1: Learning environment

1. Developing positive learning environments and relationships

A positive teacher–student relationship is an important part of a classroom culture that encourages students to engage. The maths classroom needs to be a welcoming, inclusive and safe place where students are not afraid to make mistakes and peers are supportive.

Key principle 2: Students' interests

2. Linking maths learning to students' interests

Learning maths should be enjoyable and interactive, and include classroom activities that link with students' interests where possible.

Key principle 3: Ways of working

3. Being sympathetic to students' usual ways of working

Classroom activities should reflect, and be sympathetic to, students' usual or preferred ways of working. These may relate to personal preferences reflecting age or social situation, or be ways of working associated with students' vocational pathway or intended career.

Key principle 4: Making progress

4. 'Can do' attitude fostered using short-term goals, monitoring and recognising learning gains, and rewarding effort

Students respond positively when they see they are making progress. This can be achieved by setting appropriate and achievable short-term goals that support a growth mindset or 'can-do' attitude, and by recognising learning gains and rewarding effort.

Key principle 5: Importance of maths

5. Positive images and importance of maths communicated widely throughout the college

Students become more positive about maths when they see the practical and personal relevance of what they are learning and when they see maths portrayed positively across the whole college curriculum.

Key principle 1: Learning environment

Creating a positive learning environment

Creating a positive learning environment for post-16 maths students is a crucial factor in improving progress. Research suggests that the nature and quality of the relationships between students and both their teachers and their peers has a substantial impact on engagement within learning.[17]

A learning environment which fosters feelings of community and inclusion is one in which there is a mutual respect between student and teacher, there is a mutually accepted common culture within the class and students feel safe, capable, accepted and connected to their teacher and their peers.[18]

What the research shows

Students often interpret challenges in learning as a threat to their **self-integrity**. Those who lack a sense of belonging feel uncomfortable contributing to classroom discussion and reluctant to participate in lessons. This makes them less able to engage with learning.

Anxiety has long been recognised as a problem affecting learning,[20] and negative emotional responses to maths are often the triggers for disengaging.

A positive classroom culture:

- promotes positive teacher–student relationships[13]
- creates a sense of 'belonging' and helps students feel that they fit into the classroom environment
- increases learner autonomy by using a learner-centred approach, where students are involved in directing and planning their learning, and learning is related to their goals, motivations and interests[21]
- helps students to maintain a positive self-image
- encourages students to develop more positive attitudes and emotions
- reduces anxiety and negative emotional responses to maths
- allows students to maintain self-integrity when taking on challenges that have caused them to struggle in the past.

Fostering an environment that makes students feel at ease will increase their cognitive capacity and willingness to engage in maths. Interventions that foster belonging have been reliably demonstrated to boost attainment.[14]

Key term

Self-integrity is a global sense of adequacy, i.e. sense of adequacy of the whole self, not just in a particular domain.[19]

Putting it into practice

A variety of strategies can be used in a safe, inclusive environment for students, where they experience being part of a learning community.

Improving teacher–student relationships

Developing a good relationship with your students is one of the most common positive influences on students. One method of encouraging this is to explore what you have in common. This is often done by making time for informal discussion at the start of the year, where connections can be made and dialogue encouraged.

You and your students might also complete a short survey about likes and dislikes, and receive feedback on areas of shared interest. Interventions like this increase a sense of student–teacher similarity, change perceptions of each other, and ultimately improve student attainment.[22] This sort of activity can form part of a short introductory phase to the year in which you assess students' emotional needs and challenges before beginning the formal teaching of the course.

Values affirmation

Students who lack a sense of belonging, perhaps due to previous difficulties with maths, can perceive maths lessons as threatening to their sense of self, making it harder for them to concentrate on learning. Being given the opportunity to think about positive aspects of themselves is self-affirming and reduces their feelings of threat, especially in a new environment.

Values affirmation exercises, where students identify their core personal values and reflect on them, can lead to increases in the number of students passing their exams.[14] It is important that these exercises are framed as enhancing student identity, not as activities to help underperforming students, as this reinforces the threat.

Key idea

The DfE Behavioural Insights Team evaluated the impact of values affirmation exercises via a randomised control trial across 13 FE colleges. In total, 4381 students were involved in the trial. Students completed the exercise up to four times throughout the academic year in their regular English or maths classes. The intervention led to a 25% or 4.2 percentage points increase in the number of students passing their exams (from 16.7% to 20.9%), a statistically significant improvement.[14]

Mentoring and support from trained volunteers

Trained volunteers can support you by providing additional mentoring for students, including emotional support and personal encouragement to help build their confidence. Trained volunteers can set up regular meetings, either virtual or face to face, to explore reasons for individual students' non-attendance in maths classes. They can also support students who do not cope well in class and set and review targets with individual students or small groups.

Trained volunteers can support you by mentoring students

Social belonging

It is common to feel a lack of belonging in a new environment or one resembling a past uncomfortable situation. Students should recognise that these feelings are temporary and can be changed. Testimonies from other students help them to recognise that feelings of not belonging in the maths classroom are normal and will pass. This can improve attendance, particularly among marginalised groups[23], leading to better attainment.

Key principle 2: Students' interests

How maths can be linked to students' interests

Creating a link between maths and the lives of students is a key connection that helps students understand the relevance of the subject to them personally.

Where possible, learning resources for maths should include a meaningful and realistic link to areas of life that students find interesting. This may include an introductory discussion about a relevant application of the concept or mathematical principle. Alternatively, context that accurately reflects a life situation that students have experienced, or may encounter in the near future, could be used.

Find out more

More on the ways context can be used to help student engagement can be found in the CfEM Contextualisation Handbook.

What the research shows

Students may find it difficult to see the connections between the maths they learn in a classroom and the maths they may use in everyday life. Research concerning adult learners and street sellers has demonstrated this principle.[24, 25]
Nunes, Schliemann and Carraher (1993)[24] found that children who were street sellers in Brazil dealt competently with the maths involved in selling goods on the street, but could not complete similar mathematical calculations in a more formal situation. Similarly, Lave (1988)[25] observed that adults who performed calculations accurately while shopping did not recognise the same maths in a classroom situation.

Research with FE students shows that they find maths more relevant when there is an **immediacy of usefulness**[11] for them personally. Once they understand the relevance of maths to their own lives and interests they become more motivated and engaged.[13, 26, 27] This may involve making meaningful connections to their lives that demonstrate the actual use value or simply showing how maths is a part of life outside the classroom.

Contexts used to demonstrate the relevance of maths need to be authentic if they are to be recognised by students as realistic or meaningful.[11]

Key terms

Immediacy of usefulness means that the maths is related to a current situation that students are experiencing or one that they can imagine in the near future.

Putting it into practice

There are three ideas to consider when linking maths learning to student interests.

- Connect – introducing topics with an example of how the maths is used in a relevant vocational or life situation. This can be reinforced by further references to relevant practical uses during teaching.
- Integrate – using a meaningful context for a maths problem that also accurately models the maths.
- Relate – refer to when the maths has been, or will be, used in students' main study programme.

Teaching groups for maths may include one vocational area, or a mix of vocational areas. These need different approaches but, even in mixed groups, demonstrating relevance to one of the vocational areas represented can still help show maths as a useful and relevant subject.

Inaccurate details can lead to students rejecting a scenario as unrealistic and the task becoming just another 'made-up' problem. This reinforces common perceptions that maths is unrelated to real life.

Areas of interest

Students may be interested in the following areas:

- Personal finance, including situations they currently deal with (for example, planning a trip to a music festival with friends) and those they expect to encounter in the next few years (salaries, income tax, national insurance, housing).
- Their chosen vocational area. A minority may not be interested in their main study programme. Others may end up changing to another career pathway but, at the time of studying, they often have enough interest in their current study programme to engage with material related to it.
- Recent news items and issues that appear in the media.

It is important to try to find relevant areas of interest for students

Key principle 3: Ways of working

What do we mean by being sympathetic to students' usual way of working?

There are contrasting approaches to learning between maths and vocational courses. The GCSE maths curriculum is traditional and academic in nature so does not often sit easily with vocational learning, which relates to adulthood and employment.[26] Students' ways of working and learning can be very different in their main vocational course compared with the maths classroom. Recognising and incorporating approaches to vocational learning into the maths classroom builds a culture that is more closely aligned to students' study programmes, aims and goals.

What the research shows

The research in this area comes mainly from a study of FE students learning maths.[11, 12, 26] The findings are consistent with other studies of how students' identities change during vocational training in a transition from student to employment.[28] This involves the process of becoming a professional in a vocational area.[29] In this process, students adopt new values and become familiar with different ways of learning as they move from the school environment to a vocational study programme in FE. The new approaches to learning that they experience often contrast with the way in which maths is traditionally taught, in a tightly structured, teacher-led session.[26] Appropriate adjustments in maths classrooms can help harmonise the two experiences.

Putting it into practice

Liaison with vocational teachers may help you understand the values that underpin vocational teaching and approaches to learning that are used. This may involve conversations during the planning of maths schemes of work and lessons and/or observations of vocational sessions. Access to vocational schemes of work or lesson plans may also help you understand the common approaches used.

Note that where students from the same vocational area are grouped together for maths this approach is easier to apply. For mixed vocational groups there may still be dominant values of a more general nature and preferred ways of working, but these need to be considered for the group and not for the vocational area. It is important to ensure that your approach works well for all students.

It can be helpful to talk about different teaching approaches with vocational teachers

Practical interventions

Greater harmonisation of values and approaches to learning helps avoid the common perception that maths is disconnected from a student's study programme and is just an 'add on'. This might be achieved in two ways:

1. Developing a culture in the maths classroom that promotes (or at least recognises) the values that underpin the vocational culture of the college and, if relevant, the values important to a specific vocational area. For example, entering the world of work is an important vocational value and this could be encouraged in the maths classroom by:
   - treating students as adults
   - helping them develop some responsibility for their own learning
   - having work-related discussions about maths.
2. Adopting some of the ways of learning that are used in vocational areas and having respect for students' preferences for different approaches. These can include practical, 'hands on' tasks, using digital technology, team or collaborative work, competitive tasks and active learning approaches.

The language of the classroom needs to reflect the values identified. This includes relating maths to key values typical for students of this age in their transition to adult life, particularly independent living and gaining employment. Examples of maths that show the relevance to these values can help create a harmonisation of classroom maths with students' values. This may include references to employment and work routines rather than simply passing maths exams. An example is developing the practical skills for a student's chosen occupation. For example, teamwork is important in areas such as public services and sport, so the use of collaborative group tasks in maths, for which the team outcome counts, reflects this value.

Practical, collaborative tasks in the maths classroom might complement more with what students are doing in their vocational course

Key principle 4: Making progress

How can a growth mindset help students make progress?

Students respond positively when they can see they are making progress. This can be achieved by setting appropriate and achievable short-term learning goals, encouraging a **growth mindset** and recognising and rewarding effort.

Key terms

A **growth mindset** is the belief that intelligence can be developed.

Students resitting GCSE maths often have a fixed mindset and feel that their ability in the subject is pre-determined and out of their control. This contributes to low motivation and engagement.

Conversely, students with a growth mindset believe that their ability in a subject is not fixed and can actually be improved with effort and hard work. Other tools that can help students' improve is using effective strategies and asking for help from others.[30]

Someone with a fixed mindset…	Someone with a growth mindset…
• Believes intelligence and talent are fixed • Believes effort is useless • Believes failure defines who they are • Hides their flaws • Avoids challenges • Ignores feedback and views it as personal criticism • Feels threatened by others' success	• Believes intelligence and talents can be developed • Believes effort will help them improve • Believes failures are temporary and views them as an opportunity • Believes mistakes are part of learning • Embraces challenges • Welcomes feedback • Views others' success as inspirational

Differences between a fixed mindset and a growth mindset

Helping students develop a growth mindset

It is possible to promote a growth mindset among students and persuade them that intelligence is not fixed and they can become better at maths through[31]:

- working hard
- making mistakes and learning from them
- seeking help from others when they need it.

Using neuroscience to develop a growth mindset

Researchers have found that students can develop a growth mindset by showing them neuroscience evidence that the brain can change.[32, 33, 34] Students are taught that the brain is like a muscle and can be 'exercised' to become stronger.

Students on mindset programmes are taught that effort, the right strategies, and good advice are important to help them develop their intelligence. They can be asked to write about what they have learned to help other students who are struggling. By doing this they internalise the message themselves.

In multiple studies with thousands of students across the US, researchers have found that students on growth mindset programmes achieve more course credits, higher grades and higher standardised test scores.[35]

Changing everyday interactions with students

Interactions with students can create mindsets that support or undermine resilience. By changing the way in which you interact with your students, you can encourage them to adopt more of a growth mindset. For example, students adopt a growth mindset when adults focus praise on process rather than ability. The table below gives some examples of this.

Turning ability praise…	…into process praise
Great job! You must be naturally good at this.	Great job! You must have worked really hard.
See, you are good at maths. You got 90% on your last test.	You really studied for your maths test and your improvement shows it.
You got it! I told you that you were clever.	I like the way you tried different strategies on that maths problem until you got it right.
You are such a good student!	I appreciate the way you kept your focus and kept on working. That's great!

How you can change your interaction with students in the classroom

Importance of effort, belief and focus on developing a growth mindset

To develop a growth mindset, students must understand and believe the following factors:

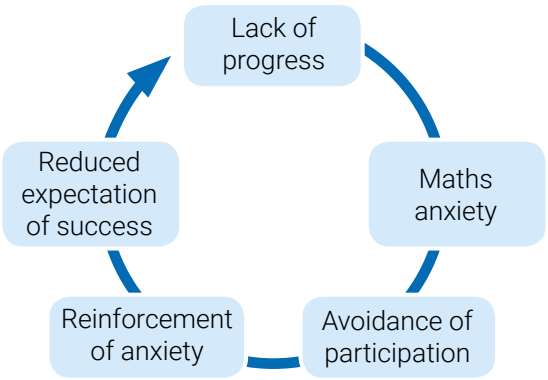
- Effort is the most important factor for success and everybody can improve.
  - Research shows that putting in effort to learn something builds and strengthens connections in the brain, giving better results when the task is next attempted.[30]
- Students should not judge their performance against others.
  - Students at different schools have been shown to perform equally well at maths, but judge their performance differently.[36] This is because they compare themselves with their classmates, which can result in students wrongly believing they are less capable than they are. Students who think they are bad at a subject often do not put in as much effort and become distracted by thoughts of failure. This tends to make them perform worse than they otherwise would. However, when people believe that they can do well, they put in effort and find it easier to concentrate, which helps them to learn more and do better.
- Students should focus on their progress in maths.
  - If a student believes they are better at their vocational course they should be discouraged from thinking it means they cannot improve in maths. Progress in maths alone should be considered and unhelpful comparisons avoided.

Short-term learning goals, recognising learning gains and rewarding effort

Students begin to engage with lessons when they feel they are learning and moving forward. Short-term learning goals that allow students to see their progress can lead to more positive emotions.[13]

Many students studying maths at post-16 have lost belief in their ability to succeed. Their previous experiences of GCSE maths have resulted in low attainment, leading to perceptions of failure, which contributes to low motivation and an unwillingness to re-engage.[13]

This challenge may also be increased by experiences of 'maths anxiety', which involve a feeling of fear, tension, and apprehension associated with maths. Maths anxiety may be associated with both learning in the classroom and taking exams. Students who suffer from maths anxiety find it difficult to participate in lessons and struggle to make further progress. This reinforces their anxiety and causes a reduced expectation of success.[36]



The cycle of maths anxiety

If students set themselves realistic short-term learning goals then they can visualise their progress to achieve their long-term goal. It is important to:

- make small steps clear to the students
- give students feedback about the progress they have made
- praise their effort and achievements (what they do), not their ability (what they are).

Short-term learning goals are important because young people need to see evidence of success to believe that they can improve in maths, despite previous experience of 'failure'.

By changing their perception of their own ability and expectations of future success, students can develop the motivation to re-engage with maths.[9] A focus on progression rather than an obsession with pass or fail can help to send a more positive signal.

Practical ways of focusing on progression

Some examples of how you might approach this are as follows.

At the start of a topic

- Ask students what they know about the topic, concentrating on the knowledge they already have. Build on this by returning at the end of the topic and reflecting on progress. It is effective to hold individual conversations with students and emphasise what they have learned, rather than what they still need to learn.
- Alternatively, students can complete a chart to show what they already know about a topic. They can revisit this after the topic has been taught to see the progress they have made. This can be supported by positive verbal feedback.
- Help students plan how they will achieve their goals. This will help them to follow up on their intentions.

At the start of a lesson

- Students rate their confidence about the topic to be covered. They select a red, amber or green card and place it on their desks to show how confident they feel about the day's topic. They review this at the end of the lesson. They will be able to see their growth in confidence and celebrate positive changes. If they have not gained confidence then you know you need to give them more support. In order to use this method it is important to first develop the right learning environment, where students are comfortable talking about what they do not understand and making mistakes.
- If you have a group of students who do not like this approach, then you can use a similar method where students vote using clickers or apps that allow you to see their responses but not those of their peers.

Key principle 5: Importance of maths

Why is it important for students to understand the usefulness of maths?

Students become more positive about maths when they see the usefulness of the maths they are learning and when it is portrayed positively across the whole college curriculum.

Making links in the classroom can help students understand the importance of maths:

- for their intended future careers
- for their main study programme, vocational or otherwise
- for their daily lives
- to help others.

What the research tells us

Research has shown that it is possible to increase students' motivation by showing that maths:

- is useful in itself and not just as a qualification[12]
- has direct relevance to students' daily lives[10]
- is of immediate, not just future, use.

Students' attitudes to activities in maths lessons are determined by:

- students' expectations of success
- the perceived value of the task
- the relevance of the task.

If students see that an activity is useful they are more likely to be motivated to engage with it. The more students engage with the activity the more likely they are to also engage with the maths. When students understand the usefulness of maths for them personally their responses are likely to become more positive.[11]

Research has also shown that if you can persuade students to believe that maths can be used to help others whom they care about, for example, by relating it to their family responsibilities, that it is more than a qualification and is a useful tool for daily life, then they are more likely to try harder in maths.[30]

It is important to foster student motivation more widely across the college to counter negative cultural attitudes to maths in society, and to change mindsets.[37] This allows students and their peers to understand and accept the importance and value of maths.[9] To bring about a change in students' attitudes it is necessary to promote positive images of maths in the college culture.

Students can use their knowledge to help their friends and family with their maths work

Putting it into practice

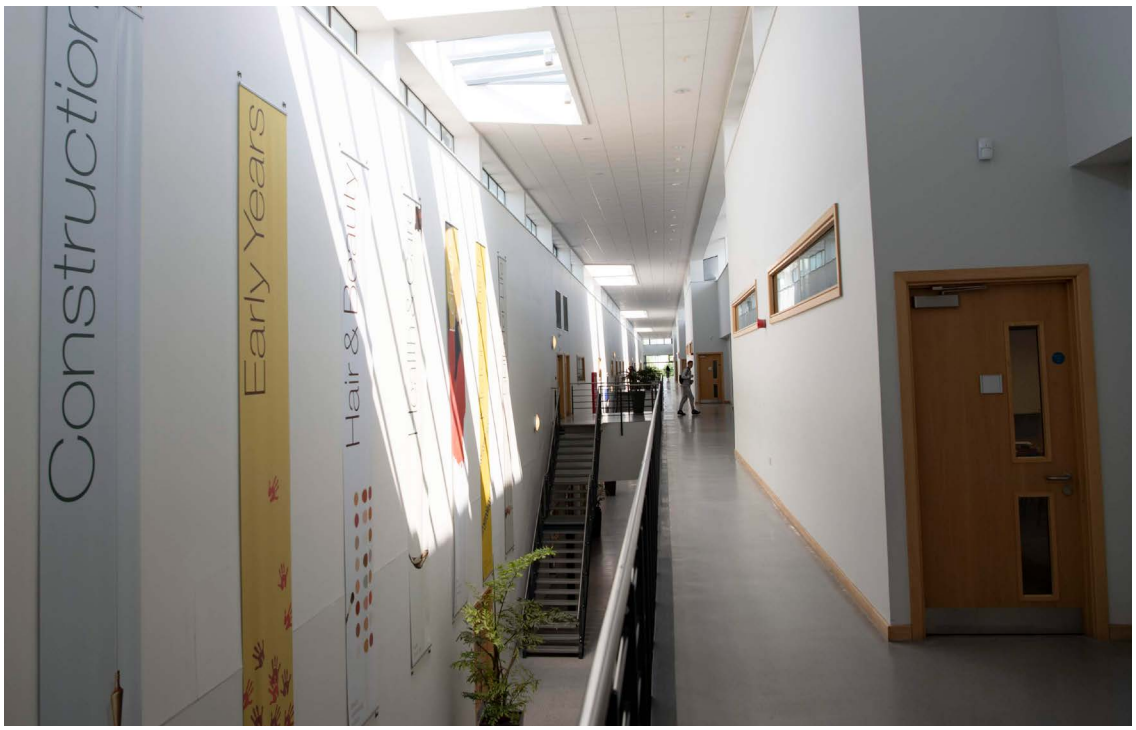
Messages from other students

Students are more likely to believe in the importance of maths (in daily life as well as for their careers) if this message is delivered by other students, not maths teachers. An intervention in Germany used quotations from older students about the ways in which maths has been personally useful to them. This led to an increased belief in the value of maths and its usefulness. The research proposed that one reason for this could be because the older students served as possible role models and their quotations were seen as authentic and persuasive.[38]

College-wide strategies

More widely within colleges the following strategies are recommended:

- Ensure that there is college-wide training and monitoring of how positive images of maths can be presented by all staff.
- Use learning resources that emphasise the relevance of maths.
- Use posters of people using maths in vocational contexts to communicate that maths is useful and helps achieve success in the workplace.
- Invite external speakers from industry or business to promote a positive image of maths as important in the workplace.
- Use enthusiastic vocational teachers to explain how they have used maths in their own careers.
- Encourage vocational teachers to stress the value of maths in study programmes and emphasise that studying maths is a priority, to present a consistent image of maths as an important subject valued by vocational staff as well as maths teachers.



It is important to introduce strategies across the whole college

Further reading

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