Accelerating Learning in Mathematics

RESOURCE 1: FOSTERING POSITIVE MATHEMATICAL IDENTITIES

A student says, "I can't do maths." Another says, "Maths is boring." A parent says, "I could never get maths"; a colleague explains, "I'm not a maths person."

Underlying such statements is mathematical identity. A person with a positive mathematical identity sees mathematics as interesting and worthwhile. They are confident in their capacity to make sense of it and accept that effort is part of the process. Such a person approaches mathematical challenges with a sense of power: "I've been stuck like this before. I know I'll find a way to move forward."

Many students in ALiM groups have a negative mathematical identity. These students dismiss mathematics as either irrelevant or boring and feel inadequate when faced with challenging problems: "I'm never going to get there, so why should I even try?"

This resource explores possible contributors to a negative mathematical identity and suggests ways to turn a negative identity around.

Why is this important?

A student's understanding of what mathematics is and their self-perception as a learner of mathematics powerfully influences their engagement and participation. In numeracy, as in literacy, some students decide early on that the rewards do not justify the effort. It is as if they have encountered a learning or confidence "hump". They will only get over it when they have picked up enough skills to tackle simple challenges and have begun to experience the intrinsic rewards of understanding and achievement. Once they are over the hump, they have no need to look back. The teacher's job is to support them to get to that point.

When a student's experience of mathematics has been negative, they can become fatalistic about their chances of ever enjoying it. If their mathematical identity goes unchallenged, it may become set in concrete, creating a self-fulfilling prophecy.

Recognising that a student has a negative mathematical identity, and probing the factors that may have formed it, can be the first step in addressing underachievement. Supporting students to develop a positive mathematical identity is essential for their long-term enjoyment of, and success in, mathematics.

Beliefs underpinning effective teaching of mathematics

- Every student's identity, language, and culture need to be respected and valued.
- Every student has the right to access effective mathematics education.
- Every student can become a successful learner of mathematics.

Ten principles of effective teaching of mathematics

1. An ethic of care
2. Arranging for learning
3. Building on students' thinking
4. Worthwhile mathematical tasks
5. Making connections
6. Assessment for learning
7. Mathematical communication
8. Mathematical language
9. Tools and representations
10. Teacher knowledge.

See *Effective Pedagogy in Mathematics* by G. Anthony and M. Walshaw, Educational Practices Series 19, International Bureau of Education, available at www.ibe.unesco.org

LIFT HORIZONS

Mathematics is the study of patterns and relationships and all strands of mathematics are based on this.

Zevenbergen, Dole, and Wright (2004) expand on this by describing mathematics as:

- a way of thinking, seeing, and organising the world – organising and analysing information or events in a systematic way
- a language – a precise way to communicate complex ideas
- a tool – useful for efficiently solving problems and making wise decisions
- a form of art – for some, mathematics is inherently beautiful
- power – a contributor to success, a social filter, a foundation for other powerful forms of knowledge.

adapted from pages 8–9

Low-achieving students often spend much more time on skill-based activities than their mathematically confident peers. This can lead to them feeling bogged down in number knowledge and strategies and prevent them from seeing mathematics as useful and interesting.

Limiting students to repetitive skills-based activities in mathematics is a bit like limiting a piano student to scales or a hockey student to drills. In each case, the learner never gets to the point of the learning.

Actions

- Consider what you emphasise in your teaching. Think about ways to help students develop a big picture view of mathematics.
- Delve deeper when a student says "Maths is boring". They may be trying to hide a sense of inadequacy but they could also be responding to the way that maths has been presented to them.
- Focus on finding patterns, identifying relationships, and problem solving.
- Prioritise exploring mathematical ideas in context and making connections between mathematical ideas.

FOSTER A SUPPORTIVE LEARNING ENVIRONMENT

A negative mathematical identity may have started with a significant bad experience in mathematics, for example, being laughed at for getting something wrong. It may also be the cumulative result of bad experiences or too few positive experiences.

The value that is given to their thinking and their contributions influences the way in which students view their relationship with mathematics.

Effective Pedagogy in Mathematics/Pāngarau BES, page 56

Mathematical learning needs to take place in a trusting community. Students with a negative mathematical identity are unlikely to contribute to class discussions because they lack confidence in their own ideas or fear making a mistake. As a result, they become passive or disengaged.

In a supportive environment, students develop the confidence to present their ideas, knowing that they will be listened to and valued. The small-group structure of ALiM groups makes them an ideal setting for students to begin actively participating in learning conversations.

Actions

- Ensure that the learning environment is safe for sharing ideas.
- Assert that mistakes are an important part of learning.
- Support students to communicate their ideas. For example, use revoicing.
- Read the Mathematical Communities of Practice chapter in the Mathematics BES and *Draft Case 1. Developing communities of mathematical inquiry* (2010) by Alton-Lee et al.

RAISE EXPECTATIONS

Sometimes students develop negative mathematical identities because their teachers have had low expectations of them. Placing a student in a "low-ability" group can powerfully reinforce a negative mathematical identity.

Students who struggle in mathematics typically spend more time on skills-based activities than their mathematically confident peers. This means that they have fewer opportunities to stretch themselves intellectually or to develop the resilience that comes from grappling with challenging problems. It can also make mathematics seem boring and irrelevant.

… teachers may inadvertently influence the achievement of their students if they are not aware of the potential of the expectations they form about students. Similarly, if the teacher feels that students in a low-achieving group cannot solve multi-step problems and so does not pose them, the students will not learn how to solve them.

Sullivan (2011), page 42

Students need to become familiar with the pleasure that arises from solving a challenging problem or from making sense of mathematical ideas.

Giving students the opportunity to engage with challenging problems shows that you recognise and respect their capacity to think mathematically.

Actions

- Examine how strongly you believe that all students can become powerful learners of mathematics.
- Take particular care with grouping arrangements.
- Ensure that tasks provide adequate challenge.

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THE NOTION OF ABILITY

Psychologist Carol Dweck has conducted extensive research into the influence of two models of thinking: a "fixed mind-set" and a "growth mind-set". Individuals with a fixed mind-set believe that abilities, talents, and intelligence are innate and unchanging. In comparison, individuals with a growth mind-set believe that intelligence and abilities can develop throughout life. This doesn't mean that everyone is the same, but rather that with effort and experience, everyone can grow.

Dweck's research has shown that praising ability can undermine motivation and learning because it reinforces a fixed mind-set of intelligence. Instead, teachers should praise processes such as effort, strategy, perseverance, or improvement.

See Carol Dweck: The Effect of Praise on Mindsets http://youtube/TTXrV0_3UjY to see how praise can influence the way children respond to challenging problems.

Actions

- Challenge absolutes such as "can't" or "never". When a student says, "I can't do maths", they are positioning themselves as someone who can't see patterns, identify relationships, or solve problems. By speaking in absolutes, they are ruling out any possibility of change.
- Reject "ability" as a limiting notion. Teach students that their brain is like a muscle that gets stronger through use and, as with muscles, strengthening their brain means exercise and hard work. Challenge is an essential part of mental growth, so if they are finding something difficult, then great! They are stretching their minds.
- Praise effort not ability.

PARENTS AND WHĀNAU HAVE A ROLE, TOO

A student's mathematical identity is influenced by the mathematical identities of their parents and whānau. It is not uncommon to hear parents say, "I didn't like maths at school" or "I am hopeless at mathematics". Parents who have no confidence with mathematics may not expect anything different of their children.

Talking to family members about their experiences of mathematics can provide useful information about home influences on a student's mathematical identity. It's important that parents recognise that how they see mathematics influences their child. Working with whānau to create new narratives about learning mathematics can support changed attitudes in the child.

Actions

- Help parents to understand that everyone can become a powerful learner of mathematics. Encourage parents to help their children to stop thinking negatively about mathematics.
- Talk to parents about "fixed" versus "growth" mindsets about ability. Encourage them to emphasise effort and progress, not ability.
- Encourage parents to participate in their child's learning of mathematics. Ease the way for parents to get involved by providing games and activities that parents and students can do together.

CREATING RESILIENT PROBLEM-SOLVERS

> *It is by engaging with tasks that students develop ideas about the nature of mathematics and discover that they have the capacity to make sense of mathematics. Tasks and learning experiences that allow for original thinking about concepts and relationships encourage students to become proficient doers and learners of mathematics.*
>
> *Effective Pedagogy in Mathematics*, page 13

The core of mathematics is problem solving. By definition, a "problem" is something that involves struggle to solve. A student with a positive mathematical identity is unfazed by challenging problems, even if they can't immediately see a way forward. They know that, with effort, time, and support, they are likely to find a solution. For these students, failed attempts are a normal and vital part of learning.

Vulnerable learners often believe that if they need to work hard to learn something, it means that they are not smart. Challenging problems can evoke negative emotions because students have to battle with their fear of failure or sense of inadequacy to even get started.

If students have a fragile self-esteem, they are likely to choose tasks that are easily achievable and will avoid more challenging tasks that require struggle and perseverance. By doing so, they are limiting their opportunities for genuine growth. Some well-intentioned teachers make this choice on their students' behalf.

Actions

Emphasise maths as problem solving. Resist the temptation to simplify tasks so that success comes easily. Instead, help students to embrace challenges, mistakes, and struggles as an essential part of learning. Give students tasks within their proximal zone of development.

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