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Scan

The journal for educators

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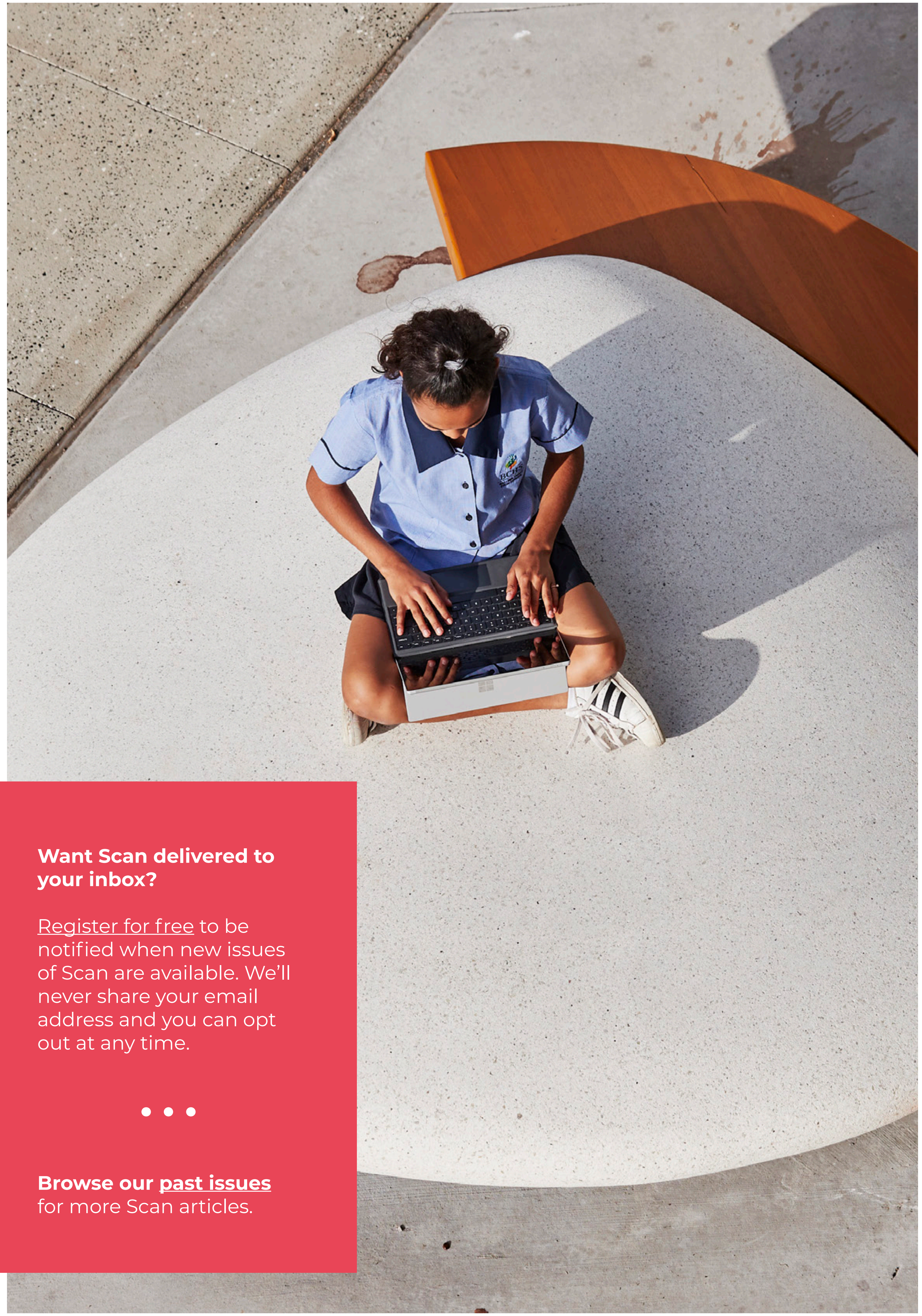
Scan is a leading refereed journal, published monthly between February and November. Scan aims to bring innovative change to the lives and learning of contemporary educators and students. Through Scan, teachers' practice is informed by critical engagement with peer reviewed research that drives improved school and student outcomes across NSW, Australia and the world. Scan aims to leave teachers inspired, equipped and empowered, and students prepared.



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Know, share, and be proud of thy expertise

Emeritus Laureate Professor John Hattie
Chair, AITSL Board and author

Emeritus Laureate Professor John Hattie explains evaluative thinking and encourages skilled teachers to own – and make visible – their expertise.

In June I had the privilege of attending the annual summit of Australia's nationally certified Highly Accomplished and Lead teachers (HALTs), hosted by the Australian Institute for Teaching and School Leadership (AITSL). It was just before COVID-19 once again closed borders, though unfortunately most of the 251 HALTs in NSW were locked out of Brisbane and had to join online, and I had to leave after a day to beat the Victoria closure! This was the fifth HALT Summit, and I have been a part of every summit since they started in 2016. This is the most important event I attend every year because it is all about teaching expertise, and the passion and expertise are palpable. Teaching expertise is at the heart of what teachers do every single day.

We know the major reason for any improvement in the education system is investment in expertise by educators (Rickards, Hattie & Reid, 2021). All else is supportive (although the other factors, especially time, resources, salary and professional learning, are not to be underestimated). Yet teaching expertise rarely gets enough attention, even among educators. I want to take a moment to unpack this so as teachers we can recognise, share and be proud of our expertise.

Evaluative thinking

Having a big impact on student learning is primarily about how teachers think, rather than what they do, and we have been investigating the specifics of these ways of thinking. We call it **evaluative thinking**, and it involves:

- reasoning and critical thinking in valuing evidence (from multiple sources) leading to 'where to next?' teaching decisions
- addressing the fidelity of implementation
- continually checking for unintended consequences
- investigating potential biases in thinking that may lead to false conclusions
- being clear to colleagues and students about what we mean by impact, and continually seeking to 'know thy impact'
- working with others (students, fellow teachers, in professional learning groups across schools) to critique our interpretations of our impact
- understanding other (teachers' and students') points of view about impact, leading to judgements of value or worth.

Such evaluative thinking leads to a more defensible balance of surface (content) and deep (relations, transfer) in lessons, assignments, and feedback. A practice informed by evaluative thinking also makes learning more inviting to students, aiding participation. When we then add listening, and responding with teaching of alternative learning strategies when the first one did not work, we have the **essence of expertise**. I would argue that the discriminating value of certified HALTs is that they are more likely to think evaluatively, and we need to better understand how these teachers think, value, and make decisions. And I heard this so clearly during the summit.

Focusing only on what we do, sharing resources, and simply watching others teach, risks missing this depth of thinking.

Focusing only on what we do, sharing resources, and simply watching others teach, risks missing this depth of thinking. The simplistic notion that all we need is great lessons, and even a novice can become a great teacher overnight, is a complete denial of the skills in developing evaluative thinking.

'In the Classroom' … contains full recordings of lessons delivered by expert teachers (often certified HALTs) with voice commentary recorded by the teacher, explaining the decisions they are making that inform their teaching in real-time.

Making evaluative thinking visible

One of the challenges we have as teachers is making this evaluative thinking visible. While it can define a novice from an expert, it is near impossible to observe, especially in the moment-by-moment decision making required in a classroom. This is why AITSL is working on a new video resource, In the Classroom, that contains full recordings of lessons delivered by expert teachers (often certified HALTs) with voice commentary recorded by the teacher, explaining the decisions they are making that inform their teaching in real-time. While there are only a couple of these for initial release in 2021, I think they could be game changers in terms of unlocking that expertise and making it available to all teachers.

Owning our expertise

A major problem I also confront is that so many educators deny their expertise. They credit the student with being motivated, putting in the effort, and sustaining it with high levels of grit and a growth mindset to complete the tasks. This is not the case. It is the teachers who improve the learning of students – yes *with* them, but they are so often **the cause of improved learning**. Until we scream this from the rooftops, we will continue to be seen by others as caretakers, deliverers of lessons, replaceable by AI and computers, and deserving low pay and respect.

We need to esteem and listen to these educators, and form a coalition of success including them, if our system is to advance ... now is a great time to speak to, and invest in, educator expertise.

HALTs are a clear manifestation that we can and do recognise expertise. Even among the current 840 HALTs, it has taken quite some encouragement for them to own their expertise. Part of this is the fear of tall poppy syndrome. (Don't get me started as a New Zealander on that bizarre Australian cultural phenomenon!) I'm happy to see them now adding HALT to their signature block and social media profiles. These small steps are how, as a profession, we can begin to really own our expertise.

The evidence across Australia is that many educators are already exhibiting the expertise we value. They are teaching in schools and early childhood settings where most learners are making more than a year's growth for a year's input. We need to esteem and listen to these educators, and form a coalition of success including them, if our system is to advance in the direction we all desire. COVID-related online learning showed parents and carers that there are remarkable levels of expertise in teaching, so now is a great time to speak to, and invest in, educator expertise.

More from AITSL

- Visit the AITSL website to find out about national certification of Highly Accomplished and Lead teachers.
- Subscribe to AITSL Mail to get the latest from AITSL, including the release of the In the Classroom videos.
- Follow AITSL on Twitter, Facebook and LinkedIn.

Parts of this article are based on Know thy expertise, written by Emeritus Laureate Professor John Hattie and published by AITSL in July 2021.

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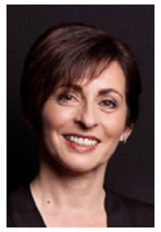
Mathematics, engagement, and technology



Professor Catherine Attard
Mathematics Education, Western Sydney University

Professor Catherine Attard describes a framework to support students' positive engagement in mathematics and considers critical elements for effective technology use.

Ongoing disruptions to schooling caused by COVID-19 have highlighted that student engagement with mathematics has never been more critical or challenging. Issues relating to student disengagement with mathematics have long been of concern in Australia and internationally (Attard, 2014; Everingham et al., 2017; Wang & Degol, 2014). Common factors attributed to declines in engagement are a lack of curriculum relevance, teaching practices that focus on content consumption, perceptions that mathematics is difficult and inaccessible, and a lack of connection within and amongst mathematics topics (Boaler, 2009; Maltese & Tai, 2010). So how do we develop, promote and support students to be highly engaged so that: mathematics is a subject they value and enjoy learning; they see connections between the mathematics they learn at school and the mathematics in their present and future lives; and they recognise the relevance of what they are learning?

First, we need to ensure we understand the true definition of engagement: it's not just about students being 'on' task, or compliant. Rather, consider shifting expectations of engagement from students being 'on' task to 'in' task. That is, students are thinking hard, working hard, and feeling good about learning and doing mathematics. From a theoretical perspective, we can view engagement as a multidimensional construct encompassing operative (working hard), affective (feeling good), and cognitive (thinking hard) domains (Figure 1). It is when the three domains converge that substantive engagement occurs. When substantive engagement occurs, it is more likely to be sustained over time.

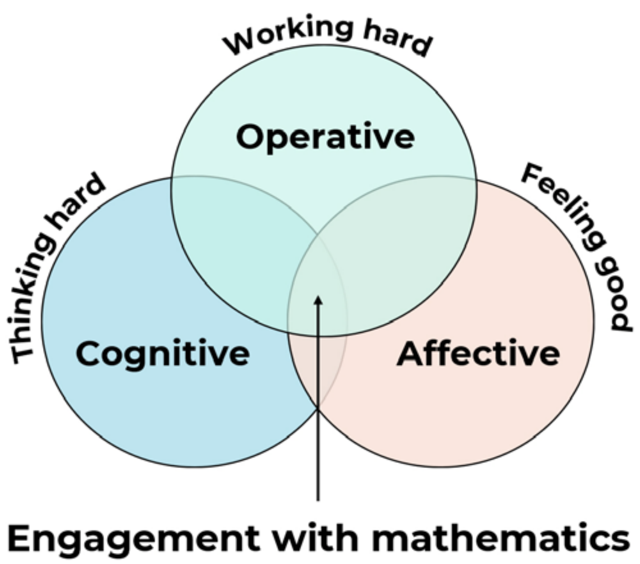


Figure 1: Sustained engagement is the convergence of operative, cognitive, and affective engagement

A framework to promote engagement

Understanding the multidimensionality and complexity of the construct of engagement assists us in designing learning experiences that promote sustained engagement for students. To assist, the Framework for Engagement with Mathematics (FEM) (Attard, 2014) articulates the foundations required to support and promote engagement within the classroom. The FEM (shown in Table 1) provides a detailed description of the influences on engagement as two separate but inter-related elements. These elements include pedagogical relationships (the interpersonal teaching and learning relationships that optimise learning) and pedagogical repertoires (the teaching practices employed in day-to-day teaching). The development of positive pedagogical relationships provides a critical foundation for engagement that is necessary for substantive, sustained engagement that incorporates operative, cognitive and affective domains. Teachers are more likely to design lessons to engage when they 'know' individual students as learners of mathematics, have deep pedagogical content knowledge, recognise the mathematics knowledge and experience they bring to the classroom, and provide opportunities for the continued development of pedagogical relationships. Teaching activities and tasks should be specifically tailored to learners' needs, and these are identified through the development of positive pedagogical relationships. The FEM identifies specific elements that contribute to the establishment and maintenance of positive pedagogical relationships and the development of engaging pedagogical repertoires.

The development of positive pedagogical relationships provides a critical foundation for engagement that is necessary for substantive, sustained engagement that incorporates operative, cognitive and affective domains.

Strategies to engage

As detailed in the FEM, there are several strategies that teachers can employ to support student engagement. For example, tasks should be relevant. However, this doesn't mean that all tasks need to have a real-life application. Making a task relevant can translate to the ways in which a teacher makes connections between the mathematics students are learning now and their prior and/or future mathematics learning. Rich tasks, number talks, and mathematical investigation and inquiry are all practices that promote student engagement. Each of these practices are open-ended and provide opportunities for all students, regardless of ability, to achieve success – and success is critical if students are to engage. Likewise, the use of technology, an integral element in most students' lives, can promote student engagement if its use is embedded in sound practice.

Aspect	Code	Element
Pedagogical relationships In an engaging mathematics classroom, positive pedagogical relationships exist where these elements occur.	PK	**Pre-existing Knowledge**: students' backgrounds and pre-existing knowledge are acknowledged and contribute to the learning of others
	CI	**Continuous Interaction**: interaction amongst students and between teacher and students is continuous
	PCK	**Pedagogical Content Knowledge**: the teacher models enthusiasm and an enjoyment of mathematics and has strong Pedagogical Content Knowledge
	TA	**Teacher Awareness**: the teacher is aware of each student's mathematical abilities and learning needs
	CF	**Constructive Feedback**: feedback to students is constructive, purposeful and timely
Pedagogical repertoires Pedagogical repertoires include the following elements.	SC	**Substantive Conversation**: there is substantive conversation about mathematical concepts and their applications to life
	CT	**Challenging Tasks**: tasks are positive, provide opportunity for all students to achieve a level of success and are challenging for all
	PC	**Provision of Choice**: students are provided an element of choice
	ST	**Student-centred Technology**: technology is embedded and used to enhance mathematical understanding through a student-centred approach to learning
	RT	**Relevant Tasks**: the relevance of the mathematics curriculum is explicitly linked to students' lives outside the classroom and empowers students with the capacity to transform and reform their lives
	VT	**Variety of Tasks**: mathematics lessons regularly include a variety of tasks that cater to the diverse needs of learners

Table 1: The Framework for Engagement with Mathematics (Attard, 2014)

Technology and engagement

The FEM articulates that technology should be used in student-centred ways to enhance mathematical understanding, forming a critical element of engaging pedagogical repertoires. This aligns with teachers consistently reporting that they use technology to boost the engagement of their students. Yet many are still resistant or unsure about what effective technology use really looks like in mathematics classrooms. Pre-COVID, technology use was at best inconsistent from classroom to classroom, and school to school, however almost all teachers have been required to use digital technologies to facilitate home learning during periods of lockdown. While its level and types of use will always be inconsistent to some degree (there is no one-size-fits-all solution), digital technologies are mandated within our curriculum. It makes sense that teachers should be equipped with strategies to effectively embed technologies into mathematics education, regardless of software, devices or access (Attard & Holmes, 2020).

In recent research on the effective use of technology in mathematics classrooms, the FEM has been incorporated into a new holistic model of technology integration (Attard & Holmes, 2020). The **Technology Integration Pyramid (Mathematics)** (TIP(M)) emerged from existing frameworks and the findings of a broader study conducted across Australian mathematics classrooms from pre-school through to senior secondary. TIP(M), shown in Figure 2, is conceptualised as a three-dimensional model to illustrate the connections and inter-related elements within it that teachers should consider when planning for the use of any technology, regardless of device, software, access and school context. The intent of the TIP(M) is to assist in future-proofing technology-infused teaching and learning as new technologies emerge. It presents a holistic means of understanding

Rich tasks, number talks, and mathematical investigation and inquiry … are open-ended and provide opportunities for all students, regardless of ability, to achieve success – and success is critical if students are to engage.

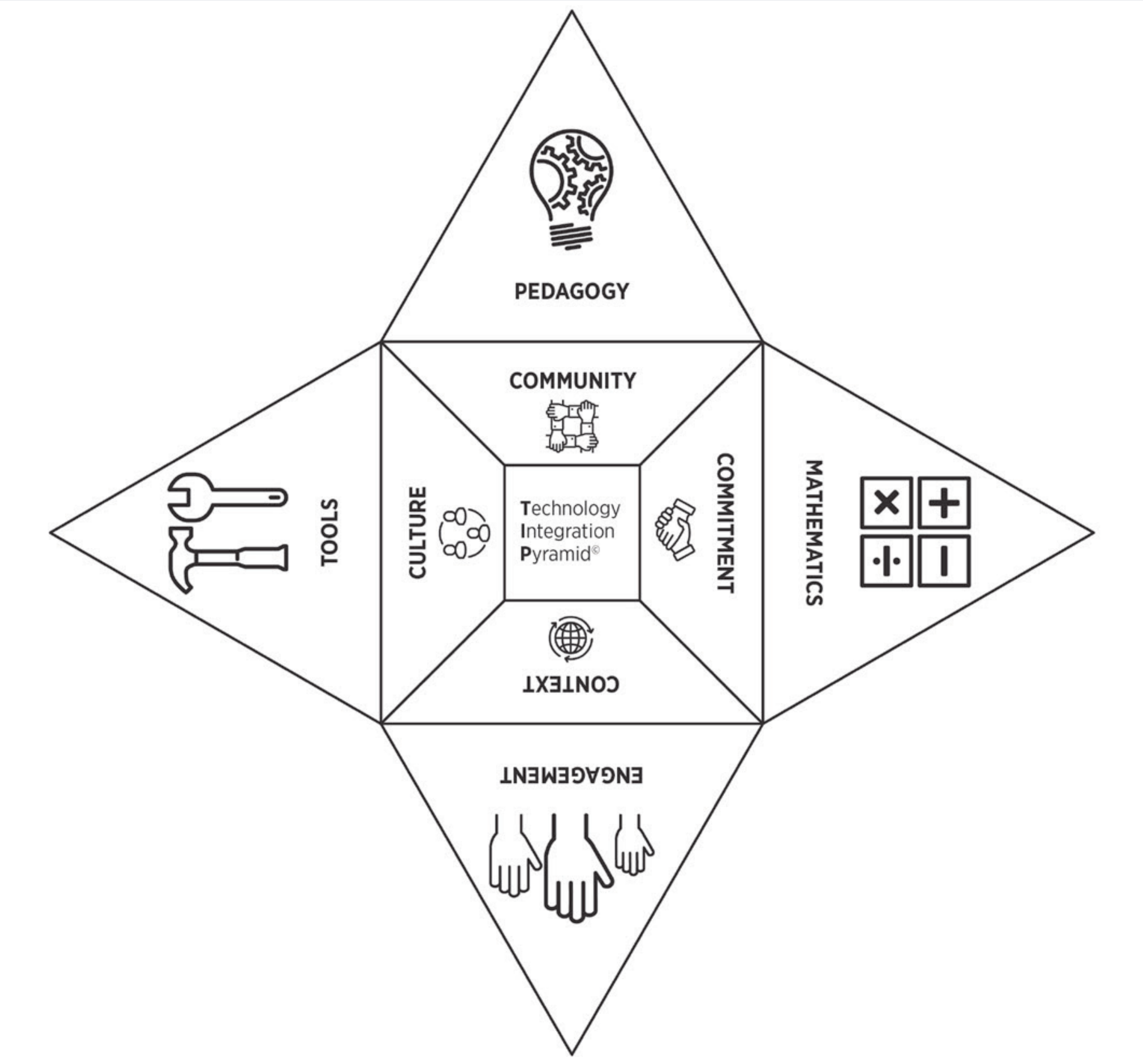


Figure 2: The Technology Integration Pyramid (Mathematics) (Attard & Holmes, 2020)

the parameters within which teachers operate and a recognition that student engagement with mathematics is a critical element for learning to occur.

Understanding your technology landscape

There are many influences on the ways in which technology is used in mathematics classrooms. We term this the 'technology landscape'. Understanding the technology landscape within a school can assist teachers in considering the opportunities and challenges within the school setting, allowing them to work effectively and realistically within those boundaries. Consider each of the dot points in Table 2. How do each of the elements influence technology-infused practices at your school or in your classroom? Are there strategies that could be implemented to improve your technology landscape?

Technology in the mathematics classroom

For effective technology-infused mathematics teaching, four critical elements should be considered: the mathematics, tools, pedagogy, and student engagement. A knowledge of the combination and interactions between mathematics, pedagogy, technology, and student engagement is critical in teachers' decision-making processes. Table 3 outlines some key considerations within each of the four elements. These considerations allow teachers to

Culture	Community	Context	Commitment
• school leadership • professional development • collaboration (teachers working in teams/individually) • innovation	• parents • other local stakeholders (business, media, government) • colleagues • students	• socio-economic status • location (regional/ rural/remote/metro) • funding • system (policy, type, restrictions)	• support (technical and instructional) • individual beliefs (mathematics, technology, teaching and learning) • teacher self-efficacy with technology • willingness to innovate

Table 2: The technology landscape: influences on technology-infused teaching

Mathematics	Tools	Pedagogy	Engagement
• content (topics in isolation vs. connected) • process (problem solving vs. fluency) • representations (dynamic) (making connections between) • computation and/ or higher order thinking	• devices (BYOD, type, number, affordances, constraints) • software (type, affordances, constraints) • administration (connectivity, updates, downloads)	• social constructivist • differentiation • assessment • grouping • number of devices (shared or 1:1) • flipped • tech for teaching and/or learning • organisation/ management • lesson design • student as consumer vs. producer	• operative engagement • affective engagement • cognitive engagement • develops positive pedagogical relationships • expands pedagogical repertoires

Table 3: Four critical elements for effective technology use

prioritise the mathematics being learned using the affordances of the available tools at hand. They also provide opportunities for teachers to consider their practices and student engagement.

The TIP(M) can be used as a holistic, interconnected tool to assist teachers and school leaders in developing technology-infused teaching practices that maximise student engagement with mathematics. The continued support in the development of teachers' pedagogical content knowledge and ongoing opportunities for high quality professional learning are critical in ensuring our students are engaged: thinking hard, working hard, and feeling good about mathematics.

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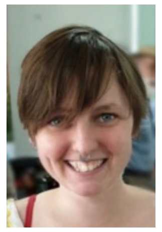
How stingless bees can be used as educational tools in primary schools



Caitlyn Forster
PhD Candidate,
School of Life and Environmental Sciences, University of Sydney

Caitlyn Forster explains the role of bees in the pollination of food crops. She focuses on native stingless bees and the significant role they can play in students' understanding of the living world.

About 35% of our crops require some form of animal pollination. Whether it is bees, birds, bats or beetles, an understanding of the biology and ecology of our local pollinators can be beneficial for students to gain an appreciation for the creatures that help to provide produce such as fruit and vegetables.

Image: 'Sugar bag bee' by Graham Wise (cropped) / via Wikimedia Commons

In Australia there are over 2000 species of bees, many of which include ground nesting bees, leaf cutter bees, reed bees and stingless bees. Usually when thinking of bees, it is the European honeybee that comes to mind. The familiar European honeybee lives in hives, produces honey and is used to pollinate a vast range of crops worldwide. However, European honeybees are not native to Australia.

In Australia there are species of stingless bees that live in colonies, produce honey and have the added benefit of not stinging. There are around 11 different species of stingless bee, but the most commonly available species in New South Wales is *Tetragonula carbonaria*. This species is located in Queensland and New South Wales and has become an increasingly popular backyard bee due to their pollination benefits, safety and reasonably easy care. Schools across NSW have shown an interest in accommodating stingless bees and there has been an increase in uptake of bee colonies within schools. Stingless bees offer the opportunity for school students to run experiments to learn about the behaviour and foraging preferences of these productive insects.

YouTube video: 'Buzzing around at Sydney's Crown Street Public School' by Melissa Ballantyne [4:18 minutes]

Studying native bees

The following sections offer some studies that can be undertaken by primary school students. These enriching outdoor classroom experiments encourage students to become more aware of their natural environment and address outcomes in the Science and technology K-6 syllabus.

Syllabus links – Living world strand

Stage 1

A student:

- observes, questions and collects data to communicate and compare ideas (ST1-1WS-S)
- describes observable features of living things and their environments (ST1-4LW-S).

Stage 2

A student:

- questions, plans and conducts scientific investigations, collects and summarises data and communicates using scientific representations (ST2-1WS-S)
- compares features and characteristics of living and non-living things (ST2-4LW-S).

Stage 3

A student:

- plans and conducts scientific investigations to answer testable questions, and collects and summarises data to communicate conclusions (ST3-1WS-S)
- examines how the environment affects the growth, survival and adaptation of living things (ST3-4LW-S).

Learning and teaching example 1: What is an insect?

ST1-4LW-S, ST2-4LW-S

Stingless bees are just one of the many examples of insects that will be present on school grounds. But what are insects? Insects are a group of animals within the arthropods classification. Insects always have 6 legs, 3 segments in their bodies, an exoskeleton and antennae. Stingless bees also have specialised anatomy including pollen baskets on their legs which are used to carry pollen and resin back to their hives. By using the model of a stingless bee provided (PDF 143 KB), students could label the significant parts of this arthropod.

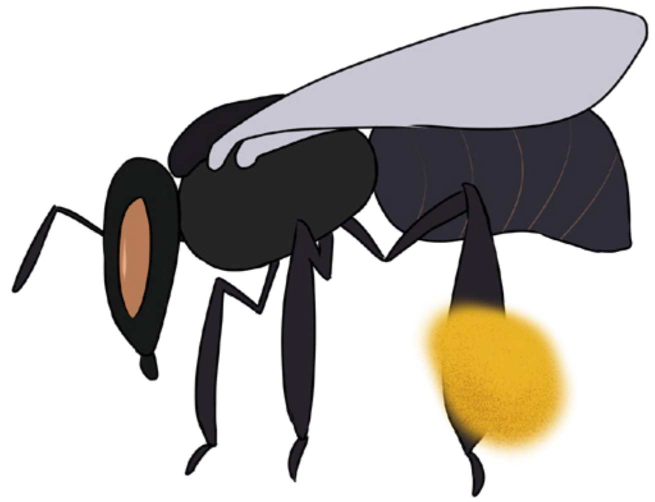


Diagram of a stingless bee for labelling

This is also a good opportunity for teachers to discuss other arthropods that are not insects, including spiders (2 segments and 8 legs), and groups such as millipedes, centipedes, or isopods (slaters).

Learning and teaching example 2: Hive splits

ST1-1WS-S, ST1-4LW-S, ST3-4LW-S

Once every year or so during spring, bee colonies that have become too large need to be split in half. Given the extra space each of the colonies can double in size again. Hive splitting is a wonderful opportunity for students to see what the colony looks like. Schools that keep bees can have students watch an experienced beekeeper dividing a colony of stingless bees. This will give students a chance to see the queen, note the honey production, and compare stingless bee colonies to conventional bee colonies. Alternatively students can watch the hive splitting process on Native bee hives and how to split them [7.16 minutes].

Experiment 1: Pollinator surveys

ST2-1WS-S, ST3-1WS-S

The simplest experiment that can be done involving native bees is a pollinator survey. These experiments are best suited to spring when there are plenty of flowers and floral visitors out and about. Experiments can be completed by getting students to run 5–20 minute surveys identifying what insects are on different plants. The level of identification can depend on the students learning stages. Potential ideas to test include colour preferences, if time of day impacts foraging activities, and whether different insects prefer particular plants.

Students can work in pairs or small groups to observe, identify and make notes on the insects they see and their foraging activities. They could also take photos for further research into identification of an insect or to support their log of the foragers they observe. If photos are taken, teachers and/or students could consider logging these pictures onto iNaturalist Australia to contribute to the citizen scientist program.

Experiment 2: Observation of returning stingless bees

ST2-1WS-S, ST3-1WS-S

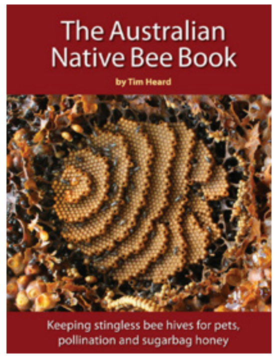
Understanding foraging behaviour can also be tested by watching bees return to their colony. This involves getting fairly close to the colony and watching returning bees.

- Counting the number of bees exiting the hive can give an indication of how active the colony is. It is possible to check if temperature impacts activity (for example, counting the bees for a few minutes at different times of day). Stingless bees can only fly after it reaches 18°C, so this is best done on days when the temperature will rise above 18°C.
- Counting what bees are collecting. Stingless bees return to the hive with three things: pollen, nectar, and resin. If bees are collecting pollen or resin, their pollen baskets will be full. More eagle-eyed students might be able to see a dark red basket, which is resin. If the pollen basket is yellow, orange, white, this is pollen. Bees that appear to be returning empty handed are likely collecting nectar. Observations like these can help in the understanding of basic questions about the colonies' need for pollen and nectar, or in testing if weather/time of day impacts foraging choice. For example, hotter days might result in bees foraging for more nectar. Older students can potentially count the colours of pollen to see if pollen collectors are looking for different flowers at different times of day. Most plants have a prime time for having the highest concentration of nectar and pollen, so collection of food should vary throughout the day.

How can schools obtain stingless bees?

Stingless bees can be an expensive investment, with colonies costing upwards of $400. While purchasing them is an option, it is also worth speaking to your local council to see if they are giving away colonies. Councils including Ku-Ring-Gai, City Of Sydney, Cumberland and Parramatta all have programs in place to increase native bee colonies in their local areas.

A valuable resource for learning and teaching about native bees is 'The Australian Native Bee Book' by Tim Heard. It is clearly presented and written information is supported by Fast Facts boxes and a vast array of colourful diagrams, illustrations and photographs.



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Writer biographies

Emeritus Laureate Professor John Hattie

Through his role as AITSL's Board Chair, Emeritus Laureate Professor John Hattie provides national leadership in promoting excellence, so teachers and school leaders have maximum impact on learning.

John's influential 2008 book 'Visible Learning: A synthesis of over 800 meta-analyses relating achievement' is believed to be the world's largest evidence-based study into the factors that improve student learning. Other notable publications include, 'Visible Learning for Teachers', 'Visible Learning and the Science of How We Learn', 'Visible Learning for Mathematics, Grades K-12', and '10 Mindframes for Visible Learning'.

Professor Catherine Attard

Catherine Attard is a Professor of Mathematics Education and Deputy Director of the Centre for Educational Research at Western Sydney University. She is also the president of the Mathematics Education Research Group of Australasia (MERGA). Catherine's research focuses on student engagement with mathematics, the effective use of digital technologies in mathematics classrooms, and mathematics teacher professional learning.

Caitlyn Forster

Caitlyn Forster is a PhD candidate at the University of Sydney. She is using behavioural economics to understand bee behaviour. Caitlyn is passionate about encouraging educators to use their local green spaces to conduct ecological experiments to inspire future generations to appreciate nature.