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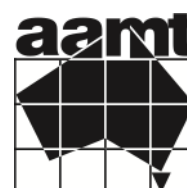
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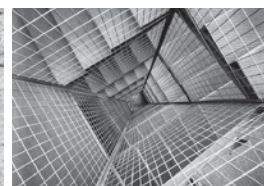
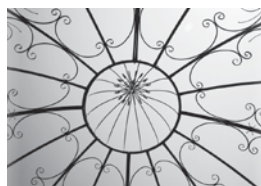
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Putting teachers first

Leading change through design—initiating and sustaining effective teaching of mathematics

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The Teachers First initiative is a grass-roots cluster-model approach for bringing together primary and secondary teachers and school principals: to analyse student performance data; design and practise activities and assessment tools; and promote teaching practices that address students' learning difficulties in mathematics. The balance of both top-down and bottom-up reform processes, seeded with the latest research evidence, allowed teachers to become both competent and confident in their effective teaching of mathematics. Its continued success is testament to our innovative school leaders and passionate teachers.

This article describes the processes developed within the North Coast region in Queensland to deliver the Teachers First initiative, and discusses the model's successes and its challenges.

The North Coast Region's mathematics experts

The North Coast Region is a diverse region in South-East Queensland comprising 219 schools. It is one of the regions of the Queensland Department of Education and Training, State schooling. It extends from the outer northern suburbs of Brisbane, through Moreton Downs, the Sunshine Coast, Hervey Bay and up to Bundaberg. Since 2012 the North Coast Region of the Queensland Department of Education and Training has been working with teachers and school principals to improve the quality of mathematics teaching and learning in schools in the region. This work has been led by Education Officers with advanced qualifications and experience in mathematics education, who are employed by the DET office in the North Coast Region. It has taken three years to reach the levels of credibility and trust now evident between the mathematics experts and their schools, but the focus of putting teachers first won the hearts and minds of both teachers and school leaders.

With the introduction of the Australian Curriculum: Mathematics in 2013, the North Coast Region of Queensland needed to build the trust, expert support, coaching and professional development to improve effective delivery of mathematics across the region's schools. It was the initial work with principals that saw them acknowledge there were some mathematical beliefs and attitudes in their schools that were resistant to the pedagogies required for deeper learning in mathematics or STEM Literacy Skills.

Feedback from early work in 2014 brought attention to one issue that the regional experts needed to address before further 'scaling up' could occur. State department employees and school leaders questioned (and wanted guarantees) that this 'free service' was of the same calibre and validity as other available resources. This perception was addressed by inviting some of Australia's leading academics to present at regional conferences, which were arranged throughout 2015 and 2016. These presentations supported both the design and quality



of the activities and assessments created. In an email communication on 1 July 2015, Professor Peter Sullivan stated that he had found the set of resources developed by our team to be “the most practical and comprehensive set of supports for the implementation of the Australian Curriculum I have ever seen”.

The region united district managers, curriculum experts and principals to push the urgency for organisational change and to be in a position to identify and work with those who might resist change (Kotter, 1996). This element had proved to be critical in determining whether school leaders were confident to invest in such a long-term commitment.

The Teachers First model demonstrated that it was possible to coordinate a long-term agenda focusing on curriculum, teaching and assessment, together with high quality evaluation and associated research (Stacey 2015). It incorporated evidence around targeting teacher orientations (Askew, 2007), teachers’ mathematical knowledge and pedagogical content knowledge (Goos, 2013; Althausen, 2014; Masters, 2016), as well as classroom routines and pedagogies for effective implementation of the curriculum (Sullivan, 2011), and embedded it into teachers’ practice.

We supported schools by developing teachers as leaders and promoted this through:

- Investing in teachers as the ultimate curriculum-makers so they become more confident in using resources productively.
- Fostering teacher capability and capacity to target the diverse needs across their classrooms and promote the deeper pedagogies needed for moving learning forward.
- Nurturing teacher confidence to successfully target student needs by steering them away from a ‘cherry picking’ or a ‘holus bolus’ approach when selecting curriculum resources.
- Making time for like-minded teachers to come together, think about what to do over the coming weeks, make mistakes, revise/refine/improve.
- Building the repertoire of pedagogies needed for both procedural and conceptual knowledge, and to balance the teaching of explicit arithmetic and facts with inquiry learning and authentic problem solving.
- Seeding the school with expert knowledge of up-to-date research in mathematics pedagogy, curriculum and assessment to reduce inconsistencies with moderation and A–E grading.

Reflections and implications

There were four identified elements from the secondary schools’ feedback that furthered the growth of this model.

Firstly, the continued sense of urgency from both national and district agendas was raising awareness on how schools were investing in improving the teaching of mathematics, and what key performance indicators they were using to measure this improvement.

The second was through a united urgency from all levels of Education Queensland, capturing and communicating the growing recommendations from highly active principal networks to invest in this model. Our work corroborated the findings from Gaffney and Faragher (2010) that any initiative must unite the personal, professional, organisational and relational dimensions. Across the region, the sight of change, the voices of change and the feel of change was rippling out from schools engaged in the program, creating further awareness and interest in what was happening. It also fuelled a quiet, positive competition between participating schools to activate strong leadership and enact the activities and pedagogies between visits.

The third element was the noted change in teacher enthusiasm and confidence, as a result of being treated as professionals. This created a bottom-up approach to effective pedagogical practice. Teachers were keen to contribute to, and try, new ideas, but often felt restricted by or inferior to 'one size fits all' resources or pedagogical frameworks. Our approach shifted the focus from teachers being expected to use every page of the new textbook or how their teaching should match the 'check list', to a more collegial bringing together of teachers and leaders to align pedagogies to deep mathematical knowledge. It was this revitalised creativity and flexibility that teachers had reported as the catalyst to higher self-efficacy.

The final element that helped cement the design of the Teachers First model as a high-calibre grass-roots approach came through visits (and accolades) from some of Australia's leading academics in mathematics. Some examples include:

In particular, the focus on the proficiencies is exemplary. The teachers and their leaders are reflective, improvement- oriented, articulate and confident. They are in the process of powerful professional learning and the progressive enhancement of the quality of their work is admirable. (P. Sullivan, personal communication, June 21, 2016).

This is a model with clear potential for both scalability and sustainability. Teachers are not handed just one recipe but instead select from a varied menu to suit their own students and school setting. In other words, teachers are treated as professionals. (Goos, personal communication, October 29, 2016).

How the model works in schools

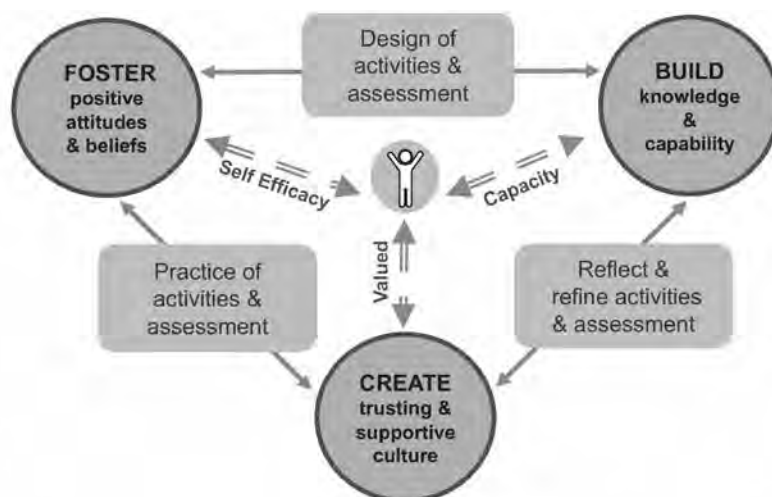


Figure 1: The current Teachers First Model used in the North Coast Region.

The Teachers First model (Figure 1) initially includes six full-day workshops spread across a semester. Schools nominated a team of teachers that would attend all six workshops and have a platform back at their schools to demonstrate activities with effective delivery. To allow demonstrations across a wide range of school cultures, the venues were selected from the geographically clustered schools. Each term, principals and teachers from all schools would contribute to best-practice networks, and share strengths and weaknesses as well as opportunities and threats. Each semester saw new schools participating, or existing schools wanting to cluster together and expand their teachers' mathematical knowledge and pedagogical practice further. The key elements of the workshops were:

- Designing diagnostic questions to enable identification and targeted interventions that cover key mathematical concepts and misconceptions.
- Building a bank of open-ended tasks that align with plans, and enable formative assessment with critical feedback both teachers and students understand.
- Designing and embedding whole-school pedagogical routines, from regular classroom demonstrations and reflections, to enact a common approach across the school.
- Running moderation sessions to analyse student responses to the new activities and assessments.
- Modifying and aligning all summative assessment pieces to ensure activation of all the proficiencies and general capabilities.

The designing and practising of tasks within collaborative clusters brought the interrelated nature of the *Australian Curriculum: Mathematics* to life for teachers (Figure 2). The anticipated student responses for each task were discussed, to enable multiple entry points and verify the assessable intent. Teachers were upskilled in strategies to orchestrate productive mathematical discussions (Smith & Stein, 2011), and build an expectation that all students need exposure to mathematical thinking and reasoning every day.



Figure 2: Teachers come together to design and refine activities, ensuring alignment with the *Australian Curriculum: Mathematics*.

Student response tasks

Our teachers had expressed the need for a diagnostic tool that would accurately identify students' conceptual understanding and move away from multiple choice tools. Teachers were trained in designing questions that would show students' level of understanding (Figure 3). By creating a series of questions each term, they supported their students by keeping key concepts active, even when they were not being explicitly taught.

To make judgements consistent across multiple schools, marking guides were created (Figure 4). All participating schools allocated a mathematics faculty meeting each term

to moderate marking and communicate findings. These meetings assisted students by identifying their current understanding of key concepts, and what they needed to aim for.

These tasks also successfully engineered classroom discussions that elicited evidence of student achievement, provided feedback to move learning forward, and activated students as owners of their own learning (William, 2011).

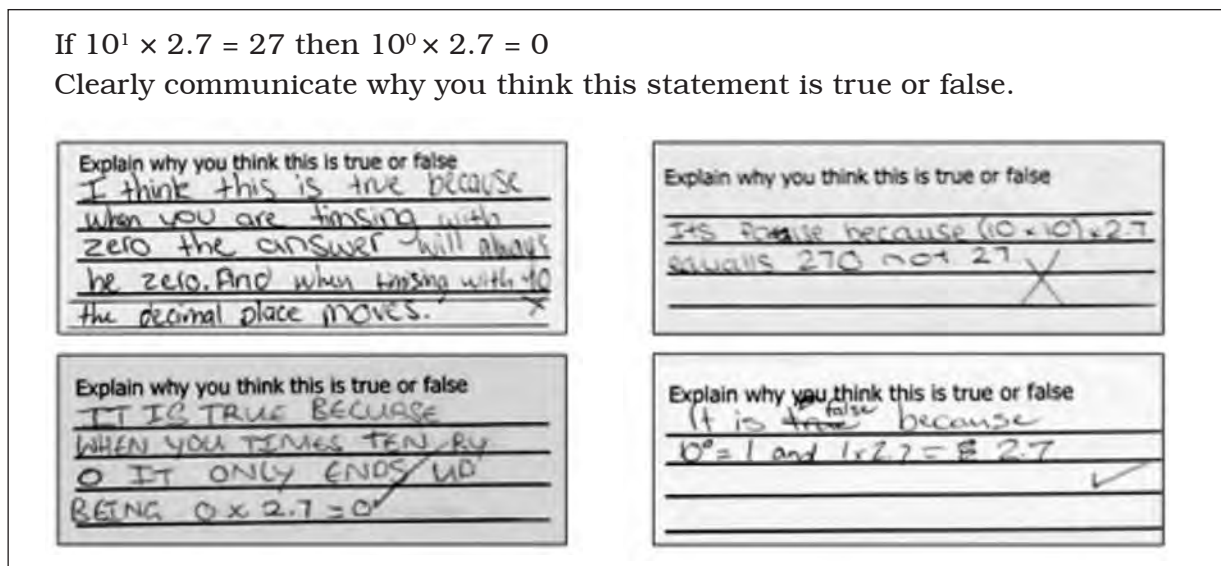


Figure 3: Year 8 student responses to a common misconception.

Score 1	Score 2	Score 3	Score 4
No attempt of demonstrates no understanding of index notation.	Incorrectly identifies as true but does not understand that 10^1 is 10.	Identifies it as false but doubt as to a clear understanding of index notation.	Identifies it as false and their reasoning clearly demonstrates an understanding of index notation.

Figure 4: Example of a simple marking guide.

Numeracy transfer workshops and activities


A common issue across the secondary schools in the region was the lack of student ability and motivation to transfer numeracy skills and concepts into other learning areas. Participating schools wanted to do more than simply include arithmetic at the start of a science lesson, for example, and call it numeracy. There needed to be credible, timely and student-acknowledged activities. Participation by as many teachers as possible was also required, if a shared vision and responsibility for numeracy was to be realised.

A 'numeracy transfer' workshop initially included willing heads of department, plus a team of teachers brought off-line to identify the potential numeracy moments in forthcoming lessons and assessment. A series of activities was then designed so that all subject departments saw numeracy being built into their units of work, rather than as an 'add-on'. Attention was given to the optimum timing of administering the activities and which department should be responsible for doing so in order to highlight numeracy transfer. These activities (Figure 5) were then trialled with the students before being shared amongst other participating schools. Teachers supported each other across faculties to deliver the activities with the necessary pedagogies to expose numeracy opportunities. The schools used the Numeracy Model for the 21st Century (Goos, Dole, Geiger, 2012) as a foundation for creating a common understanding for numeracy.

The high scalability of creating numeracy transfer across any school environment, through injecting time and valuing the workforce, was a factor in one of the project schools winning ‘Outstanding Presentation’ at the ACER Excellence in Professional Practice Conference 2016.

Mathematics: Contextualise and transfer

1. What can you infer from this data?
2. Sketch a doughnut chart for your lifestyle
3. Look for similarities and differences with friends



Mathematics: Contextualise and transfer

1. Solo artists earn less income than bands. Make an argument for or against this statement using the information provided.
2. Create a graph to show your predictions for the top 5 bands and artist of 2016.

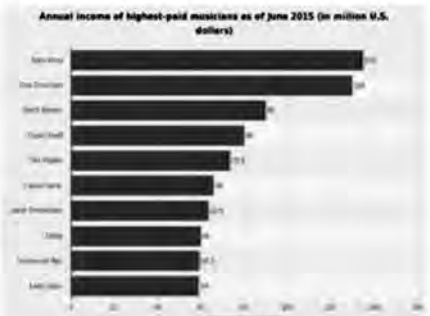


Figure 5: Year 8 examples of numeracy transfer tasks.

Teachers were led to see how effective questioning enabled a single question to offer multiple entry points and allow students to develop all the mathematical proficiencies. It is better to present one question which all students can do, at one level or another, than 20 questions that not are not available to all.

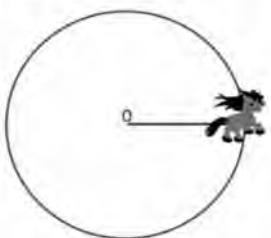
Figure 6 gives examples of two tasks that allowed teachers to really see what their students knew when faced with more unfamiliar situations. Continual use of these kinds of tasks saw a noticeable change in students’ “have a go” attitude. Evidence was collected through using open-ended tasks and monitoring student attempts over a year, as well as daily feedback between teachers and students. Teachers became increasingly vocal about the impact of these tasks, which not only revealed how well students transferred their knowledge, but also their increased persistence when trying to find multiple answers or identifying generalisations.

Open ended: Debate and defend

Question
A horse trots in a circle at the end of a 4 metre rope.

About how far has the horse trotted after completing 10 circles?

A	B	C	D
25 metres	50 metres	125 metres	250 metres



Open ended: Think and Reason

Question
A spinner was spun 20 times twice. Use your white boards to draw two sketches of what the spinner may look like.

	Red	Yellow	Blue
First 20 spins	8	5	8
Second 20 spins	10	6	4

Use mathematical language to justify your answers.

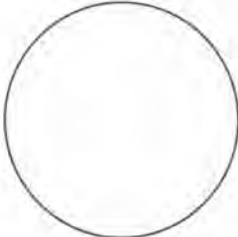


Figure 6: Grade 9 examples of Cognitive Activation Tasks.

Delivering the activities and assessment

When asked why they thought research shows that teachers are often reluctant to pose challenging tasks (Sullivan, Clark, & Clark, 2013), teachers highlighted two key factors. The first was being confronted with reprisals from their students in the face of a challenge; the second key factor was admitting to giving irregular opportunities for their students to reason, discuss, and defend their mathematical ideas.

The workshops embedded regular opportunities for teachers to observe each other delivering the classroom activities and tasks they had designed. This enabled active participation and reflection for identifying traits for the effective teaching of mathematics. It was essential for teachers to keep the rigour of these activities intact and not over-scaffold them. The tendency to reduce the demands of quality tasks (Tzur, 2008) further produced in students a lack of challenge, little resilience, and an inability to apply the necessary positive disposition to achieve mastery goals and a growth mindset (Dweck, 2000).

Workshops demonstrated effective ways to scaffold and prompt students, as it is through engaging with students and not minimising the demands of the tasks that higher achievement and effort are realised (Rollard, 2012).

All teachers were encouraged to create across-school protocols, or routines, that naturally developed from classroom visits and reflections (Figure 7). Teachers needed to experience effective instruction and interventions to successfully guide lesson design and implementation (Weiss et al., 2003). This willingness to “have a struggle, have a go” resulted in higher levels of student participation and lower incidents of disengagement and related behavioural issues. As teachers embraced problem-solving activities and felt confident in delivering these, students were seeing mathematics not only as relevant and useful, but also accessible and enjoyable (Figure 8).

Teachers reported that there was an increase in professional discussions within their mathematics faculties. This demonstrated a culture of trust, a willingness to not only listen to ideas but to have the collegial support to try things out.

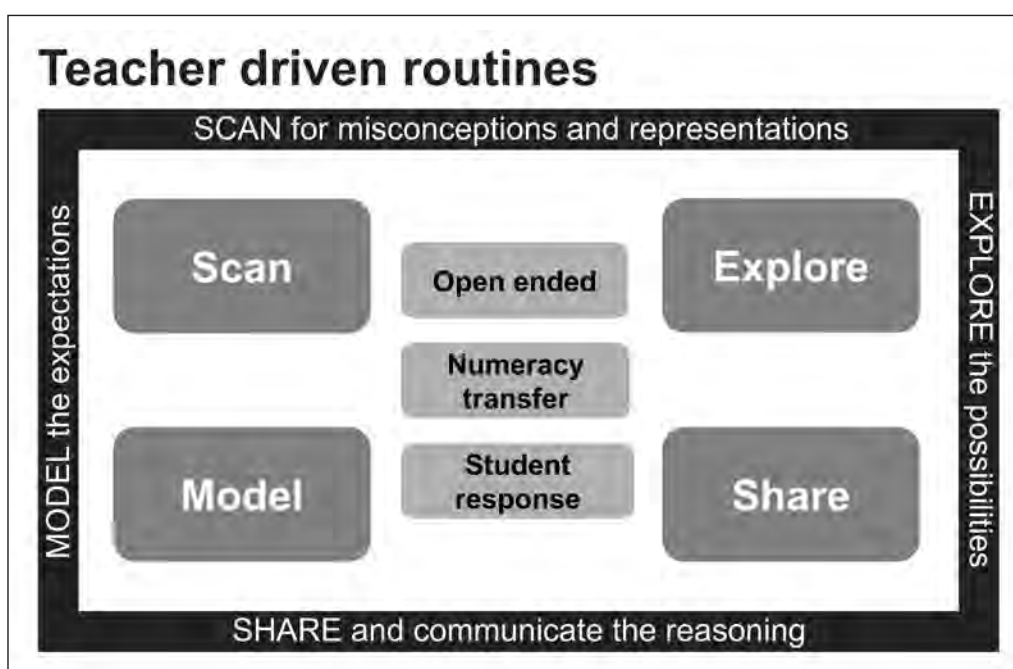


Figure 7: Teacher generated routines for display in all classrooms.



Figure 8: Students actively participating in problem solving challenges and investigations..

Final thoughts and the way forward

School leaders recognised that evaluating the ‘return on investment’ for implementing the Teachers First model should have key performance measures. For example, analysis of national testing data should look for long-term trends across all student ability bandings. Student participation rates in higher mathematics and other STEM related subjects should also be monitored for evidence of improvement. Teacher confidence and capability around effective teaching of mathematics are other important performance measures, together with what can be achieved when collaborative, school-based professional learning is appropriately supported.

By the close of 2016 there were five active clusters throughout the North Coast Region. All clusters are working towards a common goal of lifting the regional capability to effectively teach and assess mathematics. The 42 schools contained within these clusters have secured funding for continued teacher release from school duties based on reported visible changes in both teacher and student interactions with mathematics.

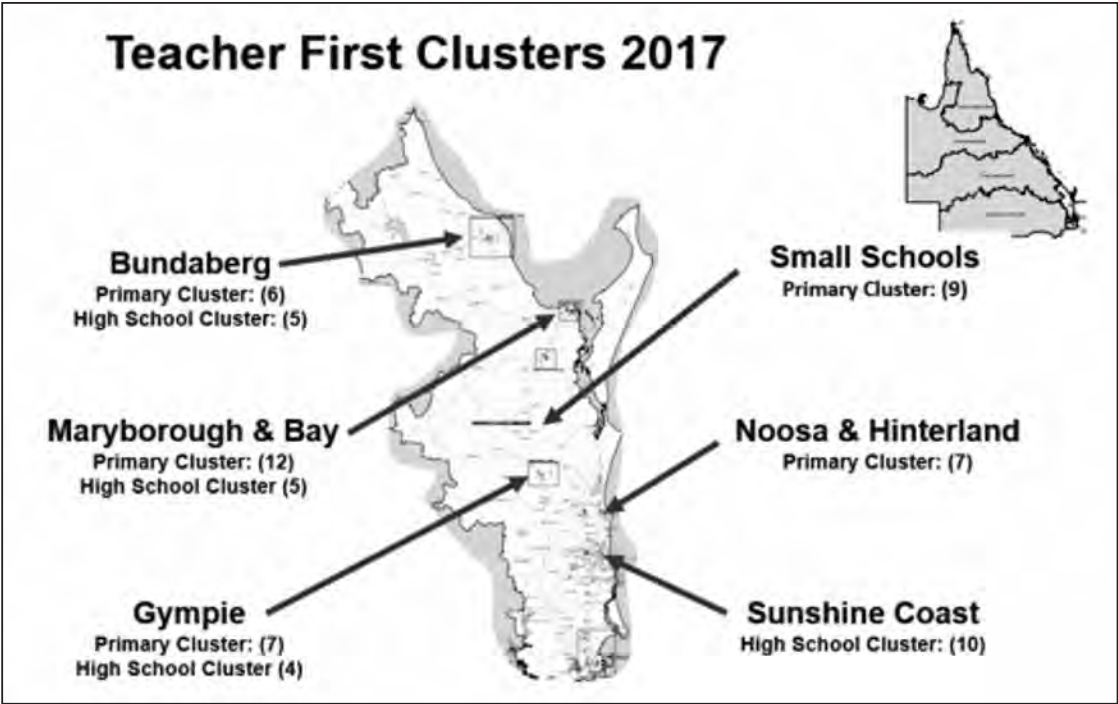


Figure 9: Map of the North Coast Region, Queensland

This project, by promoting effective teaching and delivery of mathematics, numeracy and STEM literacy skills, has certainly ignited excitement, pride and ambition for more schools to be involved. In 2017, schools which were a part of the project are continuing to invest, and new schools are committing to the Teachers First initiative (Figure 9). There will be six clusters operating, comprising 65 schools and 175 teachers trained as skilled mathematics experts. Since the start of 2016, the region's schools have redirected over \$750 000 of funding previously spent on commercial resources and schemes into developing their teachers. School leaders want to bring teachers together, to trust them as professionals and to give them the necessary capability and confidence they all deserve. Why do we invest in programs that tell us how to teach mathematics when all we need to do is to change teachers' perception of mathematics? In this way, we can ensure that their students become the confident, creative users and communicators of mathematics that this country so desperately needs.

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