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YuMi Deadly Centre
Faculty of Education

Impact Evaluation Report
Executive Summary

March 2017

Growing community through education

Acknowledgements

Traditional Owners

In keeping with the spirit of Reconciliation, we acknowledge the Traditional Owners of the lands where QUT now stands – and recognise that these have always been places of teaching and learning. We wish to pay respect to their Elders – past, present and emerging – and acknowledge the important role Aboriginal and Torres Strait Islander people continue to play within the QUT community.

YuMi Deadly Centre

The YuMi Deadly Centre is a research centre within the Faculty of Education at QUT which is dedicated to enhancing the learning of Indigenous and non-Indigenous children, young people and adults to improve their opportunities for further education, training and employment, and to equip them for lifelong learning.

The YuMi Deadly Centre can be contacted at ydc@qut.edu.au. For further information on the Centre's projects and activities, visit the website at <http://ydc.qut.edu.au>.

Impact evaluation report

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Staff of the YuMi Deadly Centre, May 2016

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List of abbreviations

AIM	Accelerated Inclusive/Indigenous Mathematics
ARC	Australian Research Council
NAPLAN	National Assessment Program – Literacy and Numeracy
OECD	Organisation for Economic Co-operation and Development
PAT	Progressive Achievement Tests
PISA	Programme for International Student Assessment
PRIME	Purposeful Rich Indigenous Mathematics Education
RAMR	Reality–Abstraction–Mathematics–Reflection
SES	Socio-economic status
TIME	Teaching Indigenous Mathematics Education
TIMSS	Trends in International Mathematics and Science Study
YDC/YDM	YuMi Deadly Centre / YuMi Deadly Maths

1 The YuMi Deadly Centre and mathematics context

The YuMi Deadly Centre (YDC), situated in the Faculty of Education at Queensland University of Technology (QUT), was established in late 2009 to facilitate teaching and learning for mathematically underperforming Aboriginal, Torres Strait Islander, and low socio-economic status (SES) students. The centre works with teachers, schools and communities to enhance students' mathematics learning and improve their employment and life chances. YDC's scope has since broadened, and YuMi Deadly Maths (YDM) pedagogy has been found to be effective with all students. The centre's aims were based on wider evidence of continued underachievement, inequity and declining student participation in mathematics in Queensland (and Australia).

YDM provides a complete mathematics program

1.1 Aims, beliefs and pedagogy

YDC's approach is based on guiding principles such as achieving whole school change through increasing teacher capacity and confidence; building student pride and positive identity; emphasising high expectations; and strengthening relationships with community, based on all students deserving the best mathematics (see box on right).

1.2 Projects

YDC has developed a pedagogy called YuMi Deadly Maths (YDM) which focuses on mathematics in terms of connections, sequencing and big ideas, teaching in terms of a reality–abstraction–mathematics–reflection (RAMR) cycle, and professional development (PD) in terms of whole school development of teacher capacity and community involvement. YDC projects utilising the YDM pedagogy are organised into three main categories according to their focus as shown in Figure 1.1.

Beliefs about mathematics teaching and learning

- All people deserve the deepest mathematics teaching and learning that empowers them to understand their world mathematically and to solve their problems in their reality.
- All people can be empowered in their lives by mathematics if they understand it as a conceptual structure, life-describing language, and problem-solving tool.
- All people can excel in mathematics and remain strong and proud in their culture and heritage if taught actively, contextually, with respect and high expectations and in a culturally safe manner.
- All teachers can be empowered to teach mathematics with the outcomes above if they have the support of their school and system and the knowledge, resources and expectations to deliver effective pedagogy.
- All communities can benefit from the mathematics teaching and learning practices above if school and community are connected through high expectations in an education program of which mathematics is a part.
- A strong empowering mathematics program can profoundly and positively affect students' future employment and life chances, and have a positive influence on school and community.

YDC believes that everyone can learn powerful mathematics

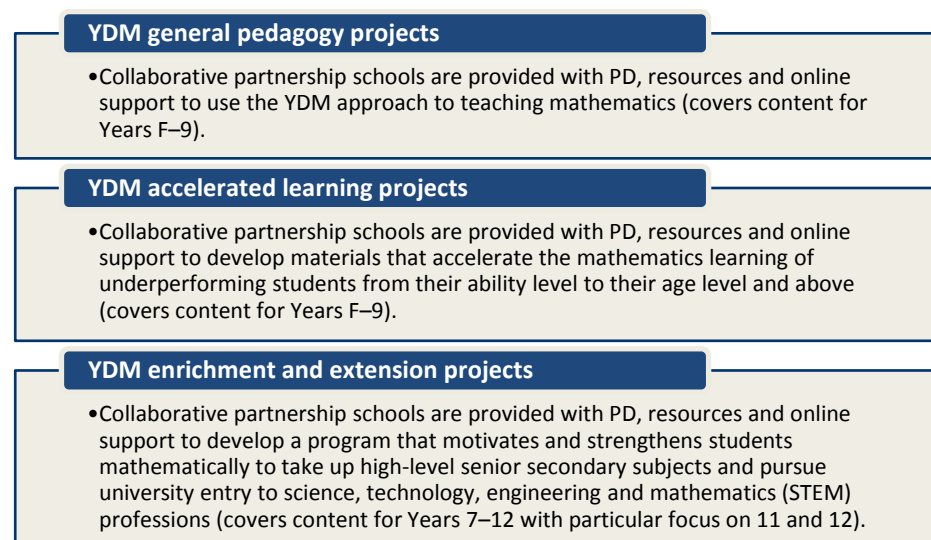


Figure 1.1 YDC project types

YDC projects have also included those with a vocational, context-based or community learning focus. A timeline of key YDC projects since 2010, showing the development from the initial three large projects to the current set of projects encompassing prior-to-school understandings through to Years 10–12, is shown in Figure 1.2.

1.3 Funding

YDC has received funding totalling \$13,635,366 over the last eight years (2009–2016) to support its projects. This funding has come from competitive, government, industry, internal QUT and philanthropic grants, and directly from schools through self-funding (Figure 1.3). The high number of schools willing to self-fund YDM training (\$2,904,151 or 21% of total funding, from 81 schools) is evidence of the impact and success of the program. YDC's successful 2015 bid for \$3.4 million in funding from CSIRO in partnership with BHP Billiton Foundation to deliver YDM to a minimum of 60 schools in the PRIME Futures program is YDC's largest single grant to date.

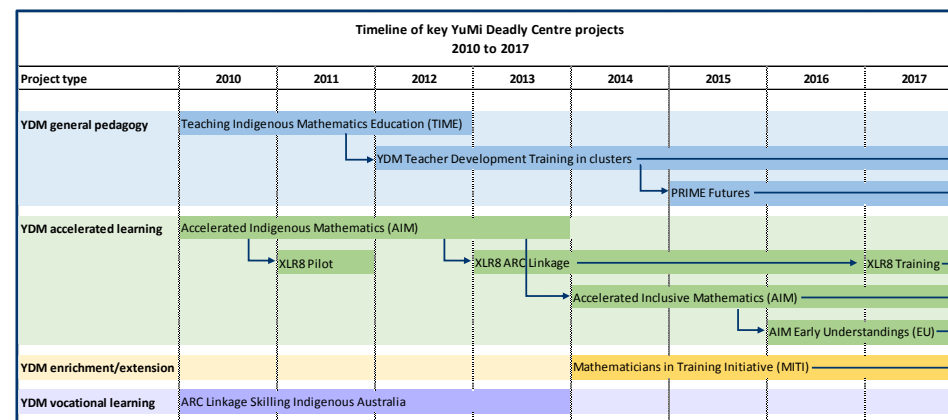


Figure 1.2 Timeline of key YDC projects since 2010

YDC project outcomes have been recognised with continued funding

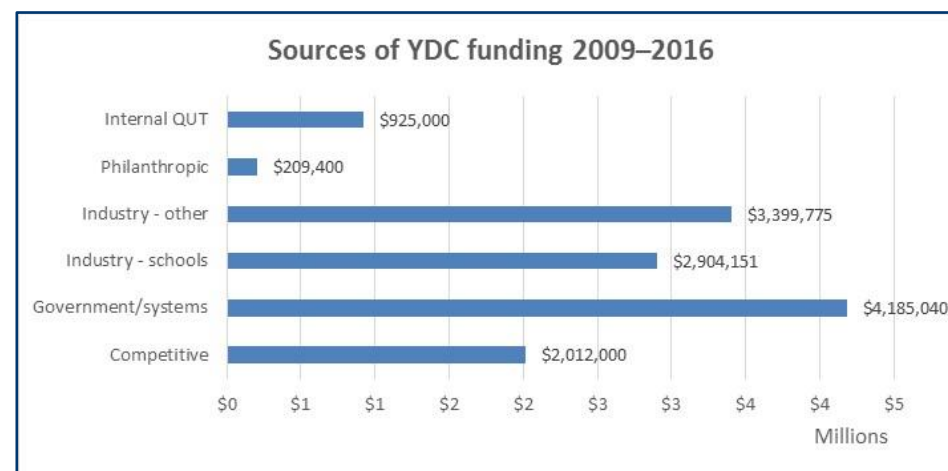


Figure 1.3 Sources of YDC funding 2009–2016

1.4 Mathematics education context

The work of YDC is undertaken in a context of overall decline in Australia's results on various international measures of mathematics achievement such as the OECD's PISA tests (Thomson, DeBortoli, & Underwood, 2016) and Trends in International Mathematics and Science Study (Thomson, Wernert, O'Grady, & Rodrigues, 2016).

There are also significant and sustained gaps in achievement between students from lower and higher socio-economic backgrounds with geolocation and Indigeneity also contributing to educational achievement gaps.

This inequity and underachievement exists in a context where Australia has a growing demand for mathematics, yet a shortfall of qualified maths teachers. The YDM approach to teaching mathematics is designed to improve students' mathematical skills and performance, thereby increasing the pool of students available to meet demand and ameliorating the cycle of underachievement in mathematics within Australia. The YDM pedagogy was developed to ensure equity in teaching regardless of students' background.

YDC projects have been developed to overcome inequity and underachievement

1.5 RAMR cycle

The RAMR cycle evolved from an analysis of mathematics by Indigenous mathematician and mathematics educator Dr Chris Matthews. RAMR was based on the cycle within his Goompi model (Figure 1.4). This model was designed to take account of the cultural capital students bring to the classroom, to relate to the nature of mathematics as a human construct, and to negate the traditional Eurocentric nature of school mathematics. The YDM RAMR cycle (Figure 1.5) provides a metacognitive framework that supports teacher design of instruction by providing a structure for lessons and units of work.

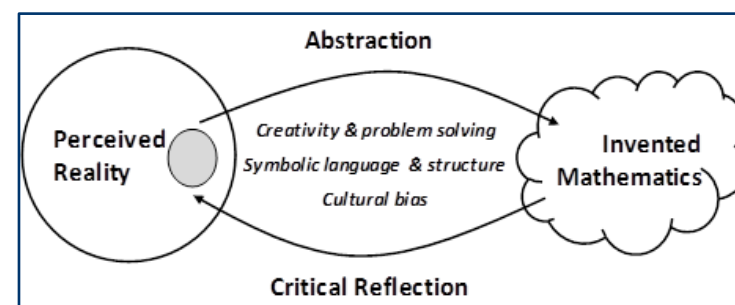


Figure 1.4 The Goompi model (Matthews, 2009)

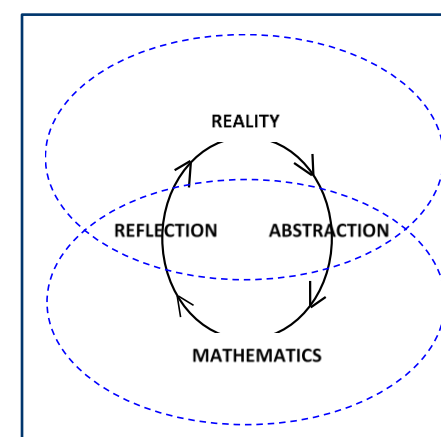


Figure 1.5 The YDM RAMR cycle

The RAMR cycle provides a pedagogical framework for planning, teaching and learning mathematics

2 Impact on students

2.1 Student achievement

“One thing that came out of NAPLAN this year (2015), is that the students who were in Deadly Maths ... their relative gain in the [NAPLAN] mean scale score was about 20 points higher than our non-Deadly Maths kids.”

– Principal, Remote P–10 College

YDM has a positive impact on student achievement in mathematics. Analysis of NAPLAN data indicates that YDM-active and YDM-trained schools¹ outperform their non-YDM-trained similar schools in NAPLAN. Second, data indicates that schools achieve significant improvements in NAPLAN (and other measures) after implementing YDM. Analysis of NAPLAN data demonstrates that in every year level, the mean NAPLAN numeracy gain of YDM-trained schools over two years (e.g. from Year 5 to Year 7) was larger than their similar school counterparts². Analysis of YDM-active school NAPLAN data demonstrates an even more marked impact on student NAPLAN achievement (Figures 2.1 and 2.2). For example, students attending YDM-active schools between 2012 and 2014 outperformed their similar school counterparts from Year 5 to Year 7 by more than 30%.

Analysis of a range of non-NAPLAN measures collected by YDM-trained and YDM-active schools similarly demonstrates that YDM has a positive impact on student achievement. This includes increases in the number of students improving on A–E reporting and other measures such as ACER’s PAT-Maths series, Australian Academic Assessment Services Testing, as well as in-class pre- and post-testing.

*YDM builds strong maths understanding
for improved NAPLAN performance*

“We celebrate success with an annual academic growth parade [where] we acknowledge all the students who receive an effect size of 1.0 or greater [on ACER’s PAT-Maths tests]. We had 128 students who we acknowledged. Families came and it was an absolutely huge success. These aren’t the kids who get our As and Bs – we have a lot of kids from our Special Ed program. We have the kids who continually struggle, but something has clicked with them, and they’ve shown that growth. And now they are being recognised.”

– Head of Curriculum, low socio-economic metropolitan primary school

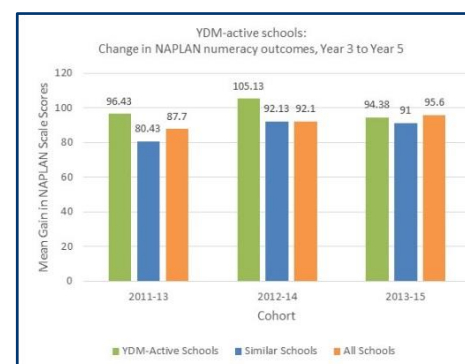


Figure 2.1 Change in NAPLAN numeracy outcomes: Year 3 to Year 5 (2011–2015)

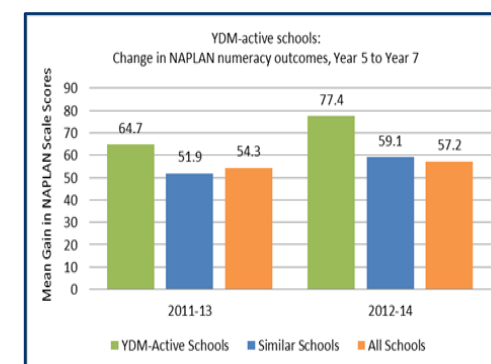


Figure 2.2 Change in NAPLAN numeracy outcomes: Year 5 to Year 7 (2011–2014)

¹ “YDM-active” refers to schools known to have implemented YDM pedagogies across the school. “YDM trained” refers to schools where YDM training has been undertaken, but there is uncertainty as to the whether there has been school-wide adoption of YDM pedagogies.

² Analysis was conducted using 2011–2015 NAPLAN data for Year 3 to Year 5, and 2011–2014 data for Year 5 to Year 7.

2.2 Closing inequities

Students at risk

Evidence shows that YDM has led to rapid improvements in student achievement for students who were significantly underperforming. A number of YDC projects have specifically targeted students who had not mastered basic skills when they commenced secondary schooling. Case studies from schools participating in these programs indicate that many students who were operating with Year 2–3 level mathematics knowledge when they began secondary schooling made significant improvements in both NAPLAN and non-NAPLAN measures. School-level NAPLAN data also indicates that YDM is helpful in reducing the number of students in the bottom two bands of NAPLAN and increasing the number of students in the middle two bands of NAPLAN.

“Children, some have had some schooling, some have had very little primary schooling ... This unit is actually going a long way towards bridging that gap between those that have prepared in primary and those that haven’t. I think it’s been brilliant actually ... [it has] uncovered a lot of problems that perhaps may not have been evident if we were just working on something else.”

– Secondary teacher participating in a YDM accelerated learning project

Indigenous students

The positive impact of YDM on individual student achievement is evidenced by individual A–E reporting data, as well as other measures (such as pre- and post-test data). This data also demonstrated the impact of YDM on closing the gap between Indigenous and non-Indigenous student achievement. Figures 2.3 and 2.4 provide examples of the convergence of results between Indigenous and non-Indigenous students participating in YDC’s “Accelerated Indigenous Mathematics” project, which ran from 2010 to 2013.

YDM accelerates learning and closes the gaps

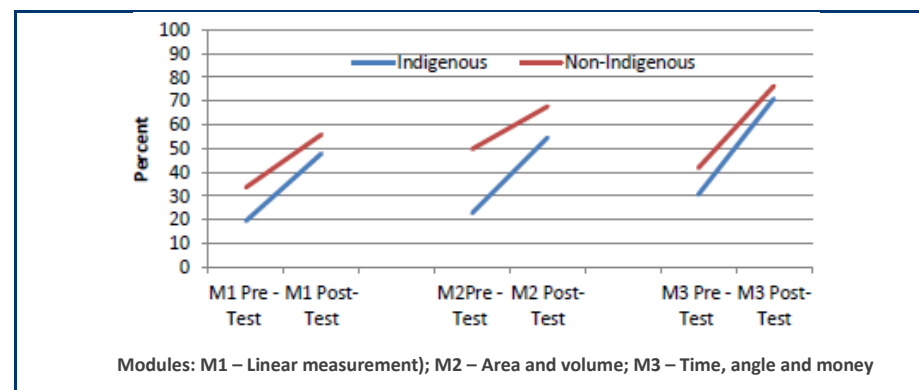


Figure 2.3 Convergence of Indigenous and non-Indigenous student results using pre- and post-test data: Measurement strand

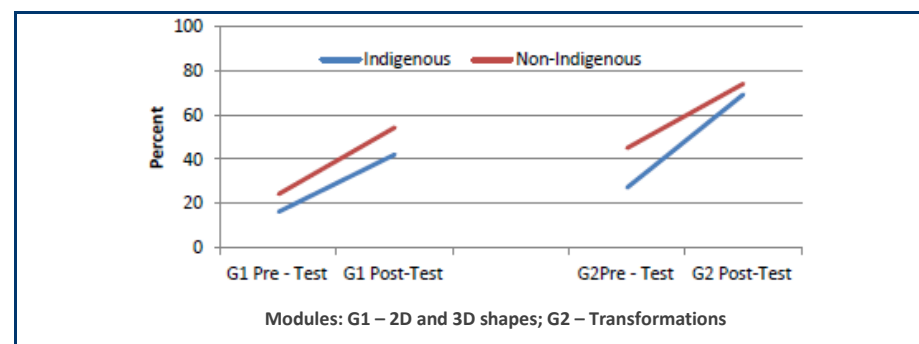


Figure 2.4 Convergence of Indigenous and non-Indigenous student results using pre- and post-test data: Geometry strand

“It is the first time students see themselves as participating in ‘proper’ high school maths on par with peers. [They’ve] gained confidence to attempt mathematical tasks that may at first appear difficult. The confidence comes from achieving success, and for some students... [YDM] has allowed them to be successful in mathematics class for the first time in their school history.”

– Secondary teacher participating in a YDM accelerated learning project

2.3 Students in low-socioeconomic areas and special school students

In addition to having a positive impact on Indigenous students, data from low socio-economic schools indicates that YDM has enabled schools to reach important benchmarks such as achieving at or above the national mean on NAPLAN for the first time. Some schools have indicated that achieving these targets has been significant because it is the first time the school has achieved national mean in any NAPLAN domain. For example, one school moved from 82% of students achieving at or above the national minimum standard in 2012 (pre-YDM) to 100% in 2016 (excluding eight EALD students) after implementing YDM. The quote below and the vignette on the right describe this positive impact for low socio-economic schools.

“We are really excited to see that our kids have achieved on par with the national average levels around the nation. It is outstanding to see that blue crop up with our students. In the past we were hitting those red zones [below and significantly below the national mean]. We weren’t hitting those standards that we’d like to see all of our kids achieve... [The improvement] all started about three years ago when we started to introduce YuMi.”

– Year 5 teacher at a low-socioeconomic school

Improvements in teaching and learning mathematics have also been evident in special schools. For example, staff at a special school that began YDM training in 2014 reported feeling energised and began to plan using the RAMR framework, by aligning it to the General Capabilities embedded in the Australian Curriculum. Teachers found ways to link students’ learning to their lived realities, for example by teaching counting during meal times and play times. The school reported significant growth in understanding of counting principles for their secondary students. Further, one teacher reported:

“With increased engagement for our students, we are seeing fewer problem behaviours during our maths rotation!!”

– Special school teacher

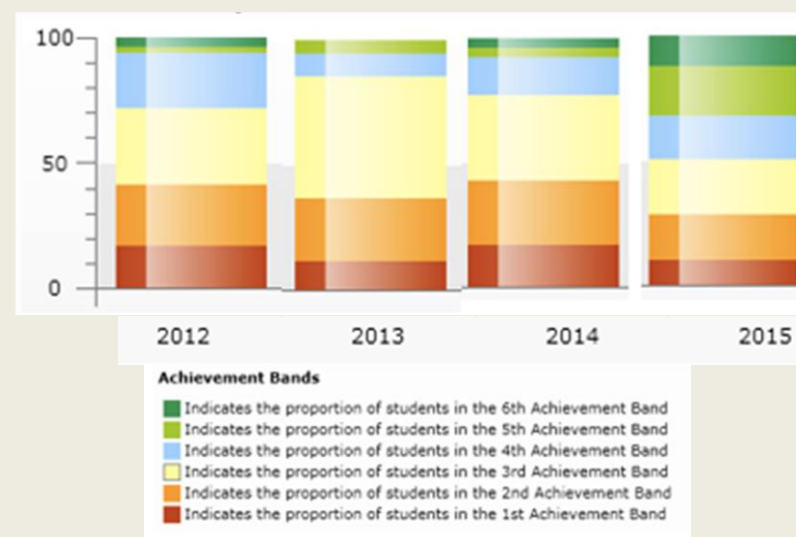
YDM is inclusive and empowers all students

Vignette: NAPLAN achievement at a YDM-active school

A primary school situated in a below-average socio-economic metropolitan region has participated in YDM for a number of years. Approximately 20% of students identify as Indigenous, and a further 15% speak English as an additional language. According to My School, in 2012 (prior to YDM), Year 3 students achieved **significantly below** the national average in numeracy.

In 2015, the first cohort of students who had experienced YDM during Prep, Year 1, 2 and 3 sat NAPLAN. The school achieved above the average for similar schools for the first time (2015 was the first time the school’s Year 3 numeracy data moved from below or significantly below the mean for similar schools.) The results also represented the school’s first ever shift from significantly below to below the national average in Year 3 numeracy. Importantly, 2015 also represented the first time that 100% of Indigenous students achieved above the national minimum standard. Looking at the spread of achievement across NAPLAN bands is also helpful in that not only are there far fewer students in the lower two bands of NAPLAN, but there are also substantially more students in the upper two bands.

NAPLAN Year 3 results by band (2012–2015):



2.4 Student engagement

“The kids’ attitude towards maths has changed. They want to see me coming now whereas they used to run the other way when they would see me coming! Now they say, ‘are you coming to our class to do fun maths?’”

– Numeracy Coach at a low socio-economic metropolitan primary school

One of the most significant positive impacts of YDM is on increasing student engagement in maths. There is a significant body of literature that demonstrates the importance of student engagement in mathematics education (e.g., Goldin, 2014; Skilling, Bobis, & Martin, 2015). This is especially important for “low-achieving students [who] are particularly at risk in so far as their inappropriate motivation may inhibit their learning opportunities” (Sullivan, 2011, p. 55). Both teacher and student reports, as well as empirical data (such as the number of students choosing to continue with non-compulsory maths in senior) indicate YDM has had a positive impact on students’ enjoyment and engagement in thinking and working mathematically.

YDM’s active pedagogy improves student attendance and engagement

During the first year of the PRIME Futures program, a survey of teacher perceptions revealed that 80% of teacher respondents perceived there had been an increase in student engagement, after only six months of YDM (Figure 2.5).

Increased student engagement has been particularly important for schools with a high percentage of Indigenous students, and schools in low-socio economic areas. Principals and teachers have reported that increased engagement is closely related to increased student confidence. Increased student achievement, combined with increased student engagement, also creates new opportunities for students who would have been unlikely to be in a position to consider tertiary strand senior mathematics subjects. There are a number of examples of students who have participated in YDM and subsequently elected to undertake Maths A in the senior secondary years.

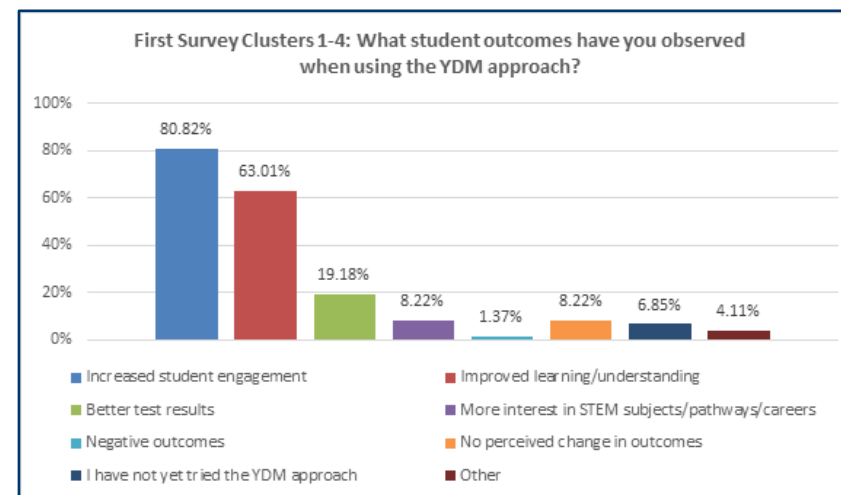


Figure 2.5 Teacher perception survey (PRIME Futures program)

“I understand maths better now. I look everywhere and link it to different things, I use myself in maths sometimes. I really like maths and I like doing it. Maths is really fun at school.”

– Year 5 student

“Kai [pseudonym] arrived in high school with attitude – a great way to cover up not understanding things. He had misconceptions ... [about] place value and the idea that in order for him to do maths he had to remember each individual lesson (rather than learning problem-solving using skills acquired). [After YDM in Years 8 and 9] he was recommended for Maths A and completed Year 11 on a solid C standard (I would have to check how he went in Year 12 for you) ... I believe his behaviour improved dramatically.”

– Secondary maths teacher

YDM’s body-hand-mind approach assists learning

3 Impact on teachers

3.1 Teacher knowledge and confidence

Data collected from across various YDC projects indicates that teachers believe YDM training has had an extremely significant impact on their confidence, knowledge and ability to teach mathematics. This was the case for both beginning and experienced teachers, and from the early years to senior secondary. Many teachers, from a range of school types and year levels, said that YDM had “demystified” mathematics, expanding both their confidence and knowledge to provide engaging and appropriate instruction for students. In a survey of principals participating in YDC’s PRIME Futures program, over 60% of principals from 18 schools reported a moderate to extensive improvement in teacher knowledge and confidence in teaching maths (Figure 3.1). Over 70% of principals reported improved pedagogical skills as well as an increase in teacher expectations of students, after approximately six months of YDM participation (Figure 3.2).

*YDM takes the fear out of maths
for both teacher and student*

For many teachers, the most significant impact of YDM has been on their confidence in teaching maths. Teachers from across a range of YDC projects described that YDM took the fear out of teaching maths, and improved their passion for maths teaching. This improvement in knowledge and confidence also translated to an increase in teachers’ expectations for student achievement. This was especially important at special schools. Accounts from teachers, YDC staff and student achievement data were triangulated to highlight changes in teachers’ expectations and practices at special schools, and indicate that YDM moved teachers from didactic, worksheet-based teaching towards engaging, hands-on teaching practice.

Evidence also shows that YDM has had an important impact on improving the knowledge and capacity of teacher aides and support workers (such as Aboriginal Support Workers) in maths teaching. This is especially important in regional, remote and remedial classrooms where support workers play a significant role in the school community.

“I always knew there [must be] a better way of teaching maths, and now I feel I understand. I am confident to plan units of work and my knowledge of how we learn mathematical concepts has developed greatly.”

– Secondary maths teacher

How has the PRIME Futures Program improved the capacity of teachers of mathematics in your school with regard to:

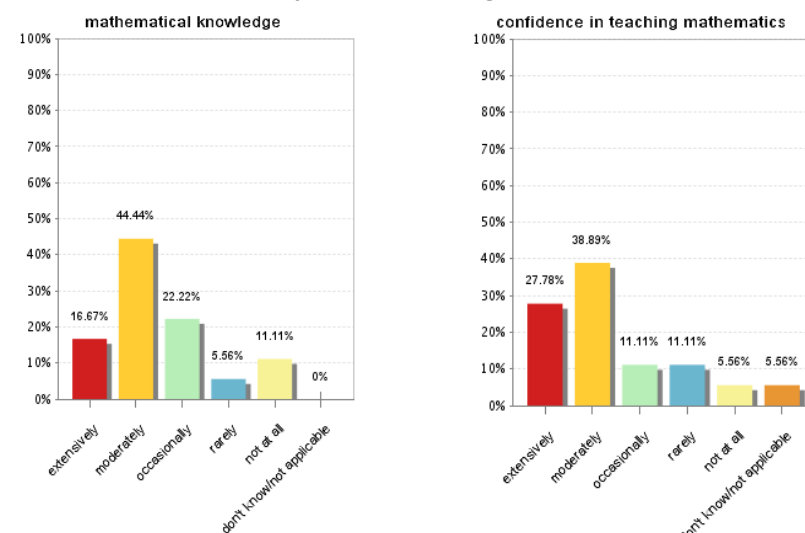


Figure 3.1 Principal perception survey (PRIME Futures program): improved teacher knowledge and confidence

“[YDM] has taken the fear out of being a teacher. I now know where to go and how to get there with students.”

– Primary school teacher

YDM PD builds teacher capacity and confidence

3.2 Out-of-field teachers

Australian schools are currently grappling with a shortage of qualified secondary mathematics teachers. At the local level, the short supply of qualified mathematics teachers has resulted in increasing numbers of “out-of-field” teachers who “have not formally demonstrated specific content knowledge and teaching techniques” to teach mathematics (Queensland Audit Office, 2013, p. 3).

Supporting out-of-field teachers is particularly important given that analysis of the Trends in International Mathematics and Science Study (TIMSS, 2011) demonstrates that Year 8 students whose teacher specialises in mathematics achieve better results. According to the Queensland Audit Office’s analysis of the Queensland education department’s database OneSchool, in 2013:

- At least 18% of Mathematics B teachers were teaching out-of-field.
- At least 46% of junior mathematics teachers were teaching out-of-field.

YDC has had extensive experience working with out-of-field teachers, and has significant evidence that participating in YDM improves both teacher confidence and knowledge for out-of-field teachers. For example in the AIM project, approximately 85% of participating teachers were teaching out-of-field.

“Because I’m not maths-trained, it makes it a lot easier for me to teach it (maths) because it’s more hands-on and practical, I can get the kids to sit down and figure it out for themselves instead of sitting there and just trying to feed them information ... I actually find teaching this maths now easier than teaching PE, which is my subject.

– Out-of-field secondary maths teacher in a remote P–12 college

YDM training enables out-of-field teachers to learn mathematics as well as mathematics pedagogy

“We are improving kids’ knowledge in maths in a way that I didn’t think possible. And I am really passionate about this. I think anybody who works with YDC and anybody who is teaching it should get out there and tell everybody they can about how wonderful it is. Because without doubt, it works. It is the best thing I’ve done.”

– Maths Head of Department in a large metropolitan secondary school

How has the PRIME Futures Program improved the capacity of teachers of mathematics in your school with regard to:

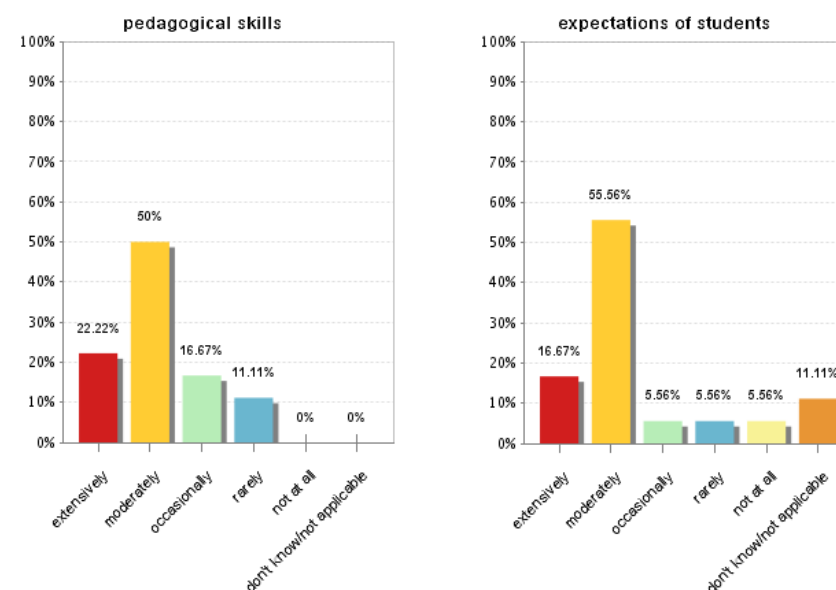


Figure 3.2 Principal perception survey (PRIME Futures program): improved teacher pedagogical skills and expectations of students

4 Impact on schools, systems, partnerships and communities

4.1 Schools and school systems

The reach of YDM's impact is evidenced by the total number of schools (249) having participated in YDC projects to date. YDM is a well-known program in Queensland and, increasingly, across the country. YDC has now worked with 216 schools located across all education regions of Queensland (Figure 4.1), as well as 12 from Victoria, 15 from South Australia and 6 from Thailand.

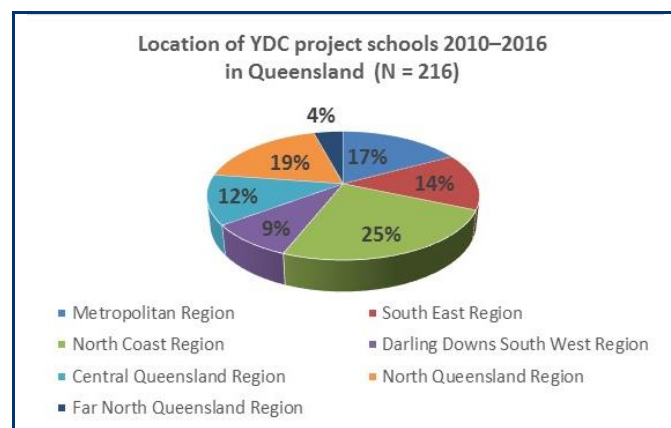


Figure 4.1 Location of YDC project schools 2010–2016 in Queensland

YDC has worked with 249 schools; 81 schools have self-funded YDM training because of its successful outcomes

Annual YDC Sharing Summits not only have an impact on teacher knowledge, but also increase the flow of knowledge across schools, fostering collaboration and creating “communities of practice”. Many teachers have described that participating in the summits was both inspiring and useful (e.g., in terms of gaining practical knowledge and building support networks).

The reach of YDM's impact is also evidenced by the \$3.4 million in funding received for the PRIME Futures program to deliver YDM to a minimum of 60 schools across Australia; the successful 2016 YDC-led QUT Faculty of Education application for Queensland Government funding to train out-of-field junior secondary mathematics teachers in the online Junior Secondary Mathematics Program; and the use of YDM as a case study in a Federal Skills and Research Capacity Report (Commonwealth of Australia, 2011).

4.2 Families and communities

YDM has provided new opportunities for schools to engage with parents and communities about maths teaching. A number of schools have reported activities involving community, such as maths fiestas, demonstration days, and events to celebrate successes, as well as teaching families how to engage students in maths-based activities at home. Feedback from parents indicates that these events, and increased student engagement in mathematics, are valued by families.

Initial evidence (from the PRIME Futures program) shows that engaging with Indigenous communities is increasing community support for increased attendance and engagement in maths education.

“The maths activities that I saw the students participating in were fun and engaging (which is the idea behind YDM). The teachers had gone to a lot of trouble to prepare the activities, and I think the students enjoyed them immensely. As a mathematics teacher, I see so much benefit in what our school is doing to engender a love of learning maths into the students. Well done!”

– Parent of a primary school child after attending a YDM “Games Night”

“My daughter participated in the NAPLAN test this year. Her results, especially in maths were well above our expectations. This result did not happen overnight and I directly contribute [sic] it to the support and encouragement provided to my daughter whilst at this school last year. The teachers helped her all year to achieve and maintain a high standard in maths, and didn't allow her to become complacent as they believed in her skills and abilities.”

– Parent of a primary school child at a YDM-active school

5 Contribution to knowledge

5.1 Professional knowledge

A central principle for YDC has been a strong commitment to building teacher professional knowledge. Through its collaborative work with multiple schools, regions and communities, YDC has contributed to the generation of professional knowledge about the teaching of mathematics. A large number of project resource books and exemplar teaching materials have been developed collaboratively between YDC staff and schools. YDC has also contributed to the national “Teach Learn Share” website.

For example, over 80 exemplar RAMR lessons were commissioned by the Queensland Department of Education following the TIME project. These lessons incorporated both Australian Curriculum Mathematics content descriptors and cross-curriculum priorities (as at the time of their production). Similarly, the TIME project led to the development of seven teacher resource books for Prep (Foundation) to Year 9, including six that detail how to teach number, operations, algebra, geometry, measurement, and statistics and probability. Appendix A summarises the professional resources, both print and online, developed through YDC projects.

YDC provides comprehensive print and online resources to schools

5.2 Scholarly and public knowledge

Besides contributing to teacher professional knowledge, YDC has also worked to disseminate knowledge to a broader professional audience through publication in professional journals and at conferences. YDC staff and HDR students have published a range of scholarly material. Some publications have been in collaboration with teachers and others were written in collaboration with external academic authors.

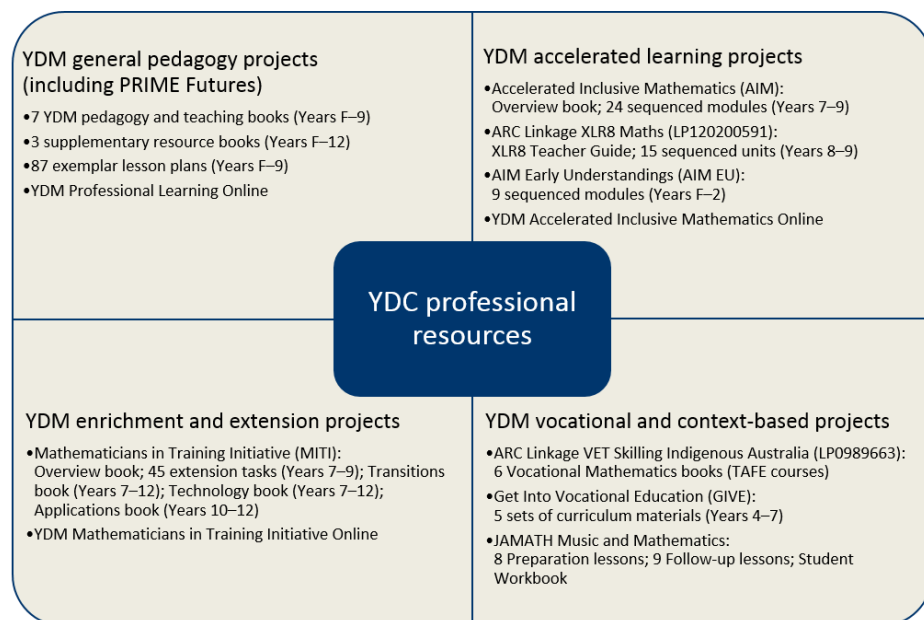
YDC staff’s commitment to emancipatory pedagogies and breaking down deficit discourses around mathematics education and Indigenous education is also reflected in their efforts to educate the wider community. YDC has worked to help break down

negative perceptions about Indigenous students’ ability to learn mathematics, through contribution to media reporting (see Figure 5.1) and public debates. For example, in 2016 YDC staff members contributed their knowledge at a round table discussion on mathematics education for the Standing Committee on Indigenous Affairs, Educational opportunities for Aboriginal and Torres Strait Islander students (<http://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id%3A%22committees%2Fcommrep%2F074678d2-0be1-42a6-af24-897683b3e9ae%2F0003%22>).



Figure 5.1 Excerpt from a media story covering YDM in a regional community

Appendix A: YDC professional resources



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