MATHS PATHWAY

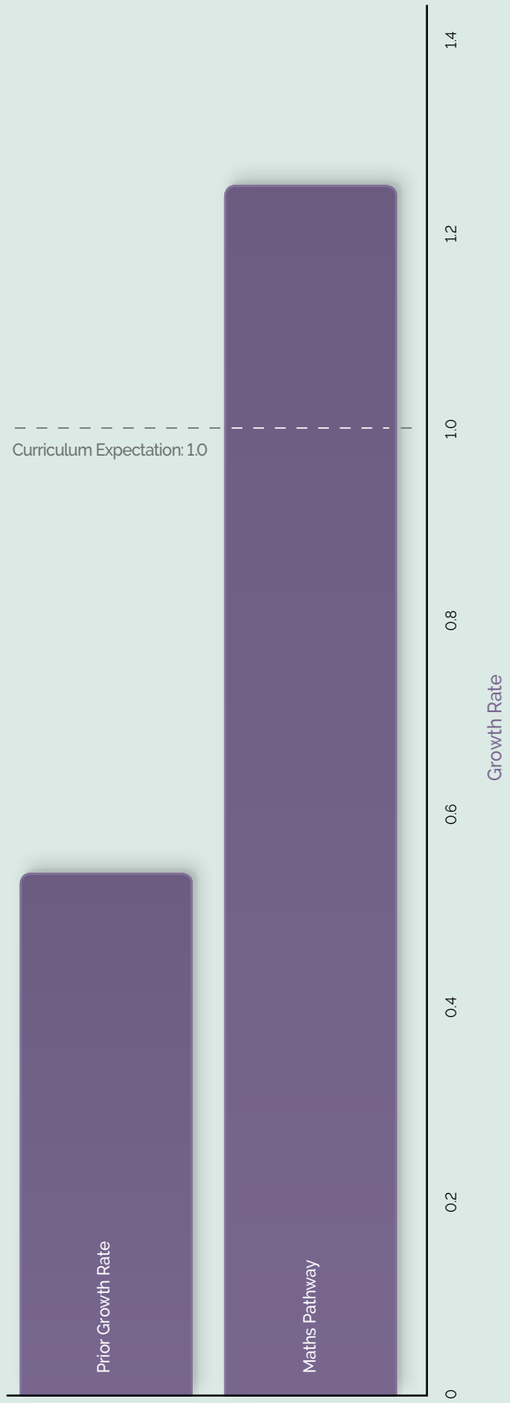
IMPACT REPORT

2018

A summary of the improved learning outcomes for over 35,000 students

The 2018 Impact Report demonstrates what the Maths Pathway community has achieved to date, as our Learning and Teaching Model is adopted across Australia.

We are grateful for — and inspired by — the work done by the teachers in our community. Some of the stories from teachers and students impacted by Maths Pathway are shared within this report.



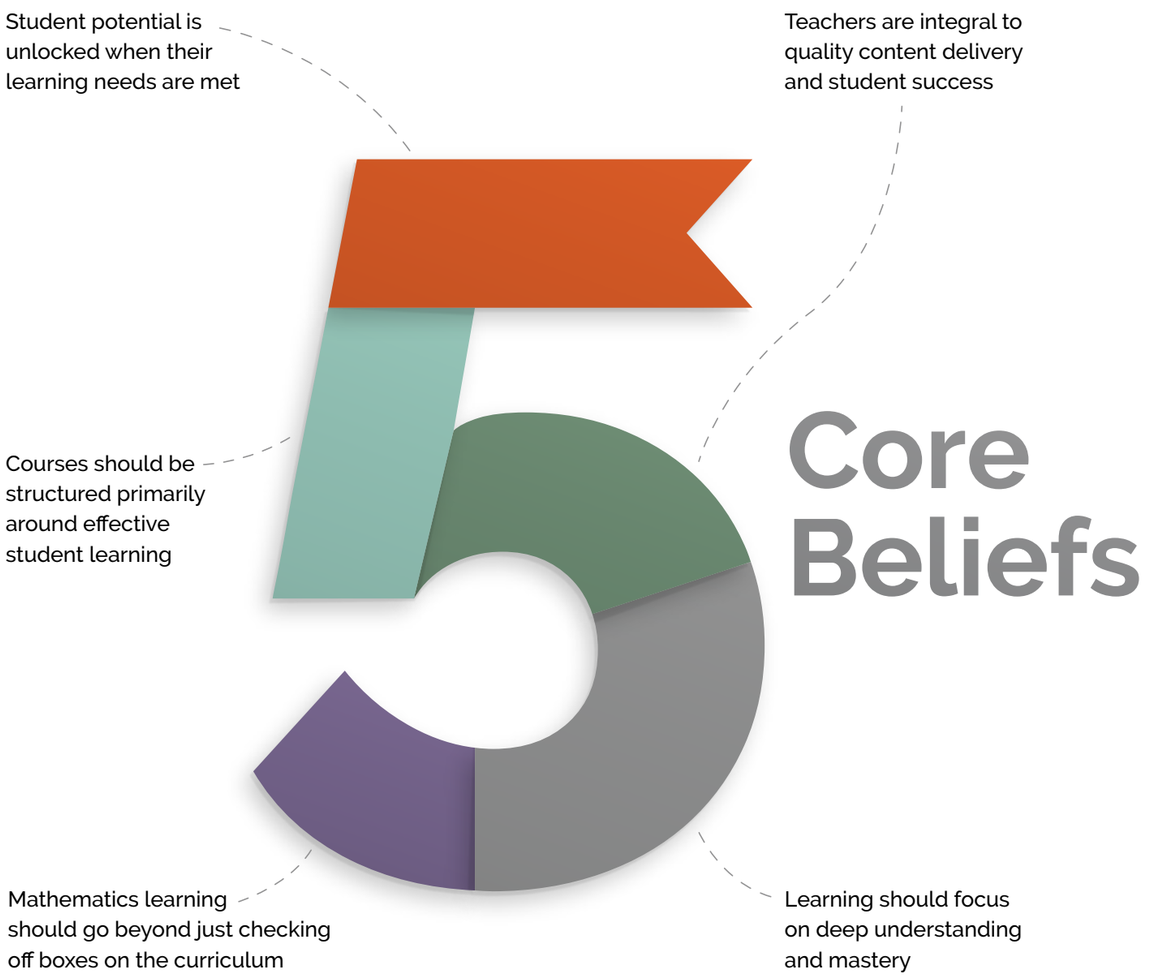
(COPY OF FIGURE 7, PAGE 27)
GROWTH RATE IN MATHEMATICS (n=22,064)

Contents

Maths Pathway envisions a world where every student's learning experience is captivating, valuable and enables them to reach their full potential. In pursuit of this goal we are creating — and working with schools to implement — a groundbreaking mathematics Learning and Teaching Model.

De La Salle College, Malvern VIC

These five core beliefs form the foundation for everything we do.



SECTION
1.0

The people building a better future

The Maths Pathway team comprises passionate educators with expertise in pedagogy, assessment, professional learning, and data analytics. Justin Matthys and Richard Wilson, former teachers and Teach for Australia alumni, founded Maths Pathway in 2013.

Richard Wilson
Chief Visionary

Richard grew up in South Africa, witnessing first-hand how a quality education could lift the outcomes of students. After working as a management consultant, Richard embraced his true passion when he joined the teaching profession.

As a teacher, Richard tested ways to invigorate our school system. Despite his love of teaching, he knew that students needed systemic change to see real progress.

In 2013 Richard co-founded Maths Pathway, working with schools and teachers across the country to re-imagine learning and teaching practices.

Justin Matthys
Chief Integrator

Originally from regional Australia, Justin Matthys pursued a tertiary education in physics. He earnt two degrees, and was part of the research group that discovered the Higgs Boson. During his studies Justin received a local Australian of the Year award for his work with underprivileged youth and the homeless community. Seeking ways to make an impact, he took a place in Teach For Australia's second cohort.

In the classroom, Justin taught physics and mathematics at all levels, and was shocked at how few mathematics students were attaining real success. Convinced that the status quo in mathematics teaching was not good enough, he left the classroom to co-found Maths Pathway.

Michaela Epstein
Head of Learning

Formerly a teacher, Michaela completed a Master's degree at The University of Melbourne examining the intent of the Victorian Curriculum: Mathematics. In addition to her role as the Head of Learning, Michaela holds the position of President of the Mathematical Association of Victoria. In both roles, she works closely with teachers and others across the community to ensure that great ideas are shared, that research and data is used thoughtfully, and that all students have success in their learning.

Joel Smith
Head of School Success

Joel completed a Master of Science (Physics) within the Higgs Boson Research Group, and met Justin through their research. He joined Maths Pathway shortly after it was founded — initially producing mathematics content. After holding many different roles within Maths Pathway, Joel now directs the company's efforts to ensure all teachers and students achieve the best results possible in their classrooms.

1.1 Education Advisory Board

The Education Advisory Board is a select group of education experts, who contribute to the ongoing innovation and refinement of Maths Pathway's approach to mathematics learning and pedagogy.

Collectively, the Education Advisory Board members have a wealth of expertise across mathematics education, and school education policy and practice. They are forward-thinkers who are passionate about improving the education system for all young people.

Charles Lovitt
Maths Pedagogy Consultant & Co-Creator of Maths300

Anthony Mackay
CEO, Centre for Strategic Education

Melodie Potts-Rosevear
CEO, Teach for Australia

Roslyn Prinsley
Head, Strategic Research Initiatives, Office of the Deputy Vice Chancellor, Research & Innovation, ANU

Lisa Rodgers
CEO, Australian Institute for Teaching & School Leadership

Sonia Sharp
Principal, Nous Group

1.2 Board of Directors

Our Board of Directors lend their extensive business experience and acumen to the governance and strategic direction of Maths Pathway.

Anthony Jon Bohm
Karen Elizabeth Bohm
William John Conn
Robert John McLean
Peter Murray

SECTION
2.0

The obligation to improve mathematics education

Over the next 20 years 44% of current Australian jobs face digital disruption,[1] and 75% of occupations currently experiencing rapid growth require employees trained in STEM disciplines.[2] For today's students to experience success in this radically different future, they must be provided with the educational opportunities that will give them the skills needed for the greatest chance of success throughout their lives.

The *Australian Curriculum: Mathematics* aims to ensure students "are confident, creative users and communicators of mathematics, able to investigate, represent and interpret situations in their personal and work lives and as active citizens".[3] Furthermore, the value of mathematics is apparent when it is viewed in the context of Science, Technology, Engineering and Mathematics (STEM). STEM proficiency helps students develop skills such as critical thinking, collaboration, initiative, and analytical thinking. Although these skills are beneficial for students' development irrespective of their future pathway, STEM skills are also highly sought after by business leaders.[4] Providing students with the opportunities to develop advanced STEM skills is becoming increasingly important.

With this demand for mathematics competency, Australia needs a corresponding increase in mathematical capability. However, Australian students' mathematics results have stagnated over the past two decades, and fallen behind the results of peers internationally.[5] This is evident through Australia's performance in international assessments, such as the Trends in International Mathematics and Science Study (TIMSS) and The Programme for International Student Assessment (PISA), as well as Australia's National Assessment Program — Literacy and Numeracy (NAPLAN). These three assessments measure different components of students' skills and understanding: TIMSS assesses factual and procedural knowledge in mathematics, PISA assesses the application of students' mathematical understanding and skills to everyday situations, and NAPLAN assesses numeracy skills from across the *Australian Curriculum: Mathematics.*

Since the introduction of NAPLAN in 2008, there has been no significant difference in achievement across most areas and year levels of mathematics at the national level.[6] This indicates that the mathematics outcomes of Australian students have not measurably improved in the past decade. These concerning trends are also reflected in the proportion of year 12 students who elect to study intermediate and advanced mathematics, which presently sits at a 20-year low.[7]

If these trends continue, the important aims articulated in the *Australian Curriculum: Mathematics* are at risk of not being met — how students learn mathematics must be reconsidered. A solution that works for every school, irrespective of the demographic, geographic, or socio-economic environment, is needed.

1 *(PwC, 2015)* ***2*** *(Becker & Park, 2011)* ***3*** *(Australian Curriculum, Assessment and Reporting Authority, 2018a)* ***4*** *(Wagner, 2018)* ***5*** *(Thomson, Wernert, O'Grady, & Rodrigues, 2015; Thomson, De Bortoli, & Underwood, 2017)* ***6*** *(NAP: National Assessment Program, 2018)* ***7*** *(Wienk, 2017)*

2.1 The challenges of improving mathematics education

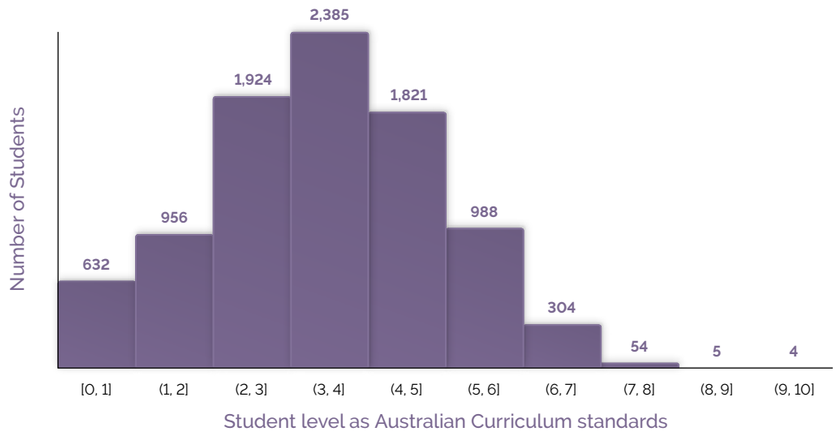
Improving Australian mathematics achievement levels is a complex task. For teachers, the day-to-day challenges of managing a classroom are compounded by the diverse learning needs of their students.

Research has demonstrated that achievement levels in a typical secondary mathematics classroom are spread across eight years of the curriculum.[8] When considering socio-economic levels and Indigenous status, this spread is even more pronounced.[9] Data collected by Maths Pathway shows a similarly wide spread of student achievement. Figure 1 shows 9,073 Year 7 students' start-of-year levels as Australian Curriculum standards. This level is measured through each student's achievement on every piece of mathematics from level 1 through to level 10A — including all gaps and competencies. For further detail on Maths Pathway data and measurement practices, see sections 5.1 – 5.5 and 8.0.

The wide spread of student entry-points makes it extremely difficult for teachers to implement best practice and to target teaching at each student's point of need.[10] The data from Figure 1 sheds light on the magnitude of the challenge teachers face, when considering the corresponding curriculum standards.[11] Without special supports or structures, individual teachers need to invest a vast amount of time to manually differentiate and scaffold their lessons to meet such diverse needs.

Expecting more heroic efforts by individual teachers is not the best way to address this challenge; teacher workload is already problematic. In ACER's ' *School Staff Workload Study*', 50 percent of secondary teachers reported they were unable to meet the demands of quality teaching. These demands include the selection of appropriate learning resources, and meeting the diverse learning needs and motivations of their students.[12] Only a third of teachers reported that they have enough time to evaluate and reflect on their own practices, effectively track and measure student progress, manage classroom behavioral challenges, and provide appropriate feedback to students.[13]

FIGURE 1
YEAR 7 STUDENTS' START-OF-YEAR LEVELS (n=9,073)



8 *(Siemon, Virgona, & Corneille, 2001)* ***9*** *(Office of the Chief Scientist, 2014)* ***10*** *(Goss, Hunter, Romanes, & Parsonage, 2015)* ***11*** *(Australian Curriculum, Assessment and Reporting Authority, 2018a)* ***12, 13*** *(Weldon & Ingvarson, 2016)*

A holistic solution is needed to deliver differentiated learning, without giving teachers an excessive workload. This idea is discussed in The Grattan Institute report, 'Towards an adaptive education system in Australia.' Underpinning the six recommendations in that report is the understanding that teachers cannot, and should not, be required to improve their practice in isolation.[14] Instead, evidence-based guidance and resources should be available to every teacher, which gives them the time, strategies, and scope to create greater impact in the classroom.

> I had an extreme variation in ability and in levels so I was spending hours working out individual programs for each student to fill in the gaps in their education. Some were extremely talented but quite behind their year level due to absences. Others were at a normal level but at a basic number fact level. Many were extremely anxious and some were perfectionists; many had no tolerance for frustration and very little resilience.
>
> **LESLEY URE, MATHS TEACHER, ST CLARE'S SCHOOL, WA**

> Before Maths Pathway, we had to stream our classes to have some hope of moving students through together, due to the high range of abilities. This was very tough work on the teachers who had the students who had struggled with maths for a long time. Grouping students into "like" groups by ability causes other problems with classroom learning, and I knew it couldn't last. With senior students, we were constantly disappointed to find they hit a wall with their studies, and drop to a lower maths course. Something wasn't working.
>
> **MICHELLE FRY, HEAD OF MATHS, REDCLIFFE STATE HIGH SCHOOL, QLD**

> Having taught year 8 maths for the previous three years, I was constantly trying to think of ways to cater for the different learning needs and levels. I often felt that students at the top end were not being pushed to see how far they could go or improve. I also felt that we often had to move on to the next topic when so many students just needed a little more time to gain understanding. Our team worked on formative assessment in order to group students during a topic and tried bridging weeks at the end of the topic. We made screencast videos as an extra resource and booklets for those students who had difficulty navigating the online text. However we never seemed to have the time to prepare all these properly so that all students were engaged.
>
> **ROSE NIHILL, MATHS TEACHER, ST MARY OF THE ANGELS, VIC**

14 *(Goss, 2017)*

Redcliffe State High School, Redcliffe QLD

SECTION
3.0

Maths Pathway — a solution with measurable impact

Maths Pathway is a holistic Learning and Teaching Model that leverages technology to enable teachers to target each student's point of need, and allows them to focus on practices that have the greatest impact on student learning. The model is currently available for Year 5 – Year 10 students, and has proven success in a broad range of school contexts. Section 3.1 illustrates the growth of the Maths Pathway community and the varied demographics of Maths Pathway partner schools.

Section 4.0 introduces the research-based practices that form the foundation of the Maths Pathway Learning and Teaching Model, including how teaching and student learning is structured within the model, and the pedagogical rigour behind the learning materials (s. 4.1). Maths Pathway teaching practices are covered in depth in section 4.2, while section 4.3 details the broad implications for partner schools and their leadership.

On average, students transitioning to the Maths Pathway model find that their learning growth rate more than doubles — student achievement data from Maths Pathway partner schools is presented in section 5.0. The driving force behind Maths Pathway is the ambition to improve mathematics education for as many students as possible, irrespective of their background or current academic standing. It is therefore critical to be able to measure and report on the impact of the model on students and schools.

Five key insights from analysis of Maths Pathway student data:

- Maths Pathway students learn more mathematics per year than Australian students typically learn (s. 5.1)
- Maths Pathway students' higher learning rate indicates improved future achievement levels (s. 5.2)
- Maths Pathway is in the high impact band for effect on student learning (s. 5.3)
- Maths Pathway students from all socio-economic backgrounds experience success (s. 5.4)
- Maths Pathway is closing the achievement gap between girls and boys (s. 5.5)

Maths Pathway's potential to effect change at the system level is discussed in section 6.0, and our vision for the future of mathematics education in Australia is shared in section 7.0.

Section 8.0 explains the data methodology used to measure the impact of Maths Pathway.

3.1 Maths Pathway partner schools

The Maths Pathway community has experienced exceptional growth and success. In 2017, 186 schools around Australia have been implementing Maths Pathway — growing from a single pilot school at the beginning of 2013, to a thriving community impacting tens of thousands of students in 2017 (Figures 2 & 3). Moreover, the number of students the community is reaching is growing dramatically, as the first cohort of students at each school introduces Maths Pathway to a higher level each year.

Partner schools come from every sector (Government, Catholic & Independent), and reflect the ICSEA distribution of Australian schools[15] (Figures 4, 5 & 6).

15 *(Australian Curriculum, Assessment and Reporting Authority, 2018b)*

FIGURE 2
SCHOOLS PARTNERING WITH MATHS PATHWAY

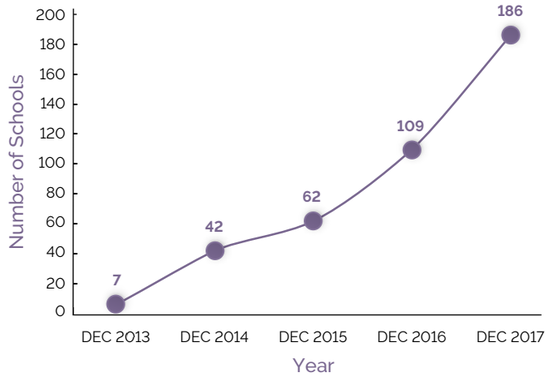


FIGURE 3
STUDENTS USING MATHS PATHWAY

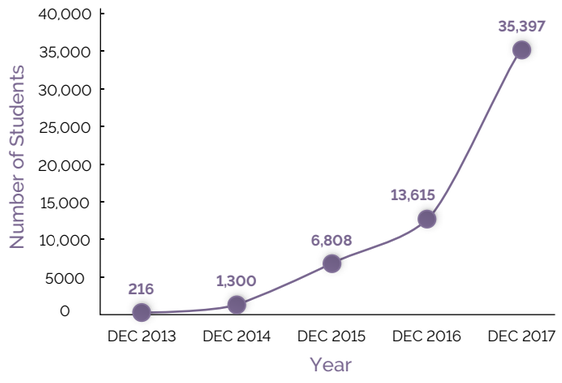


FIGURE 4
ICSEA VALUES OF MATHS PATHWAY PARTNER SCHOOLS (n=186)

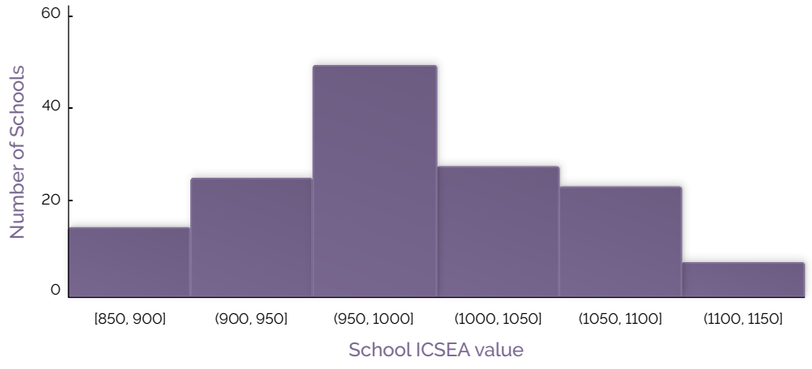


FIGURE 5
MATHS PATHWAY PARTNER SCHOOLS BY SECTOR (n=186)

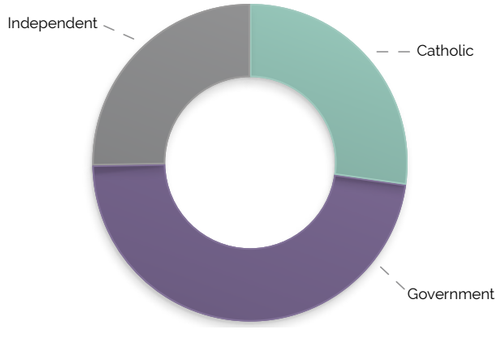
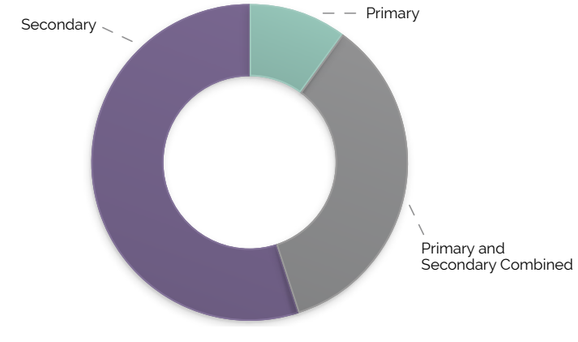


FIGURE 6
MATHS PATHWAY PARTNER SCHOOLS BY PRIMARY/SECONDARY LEVEL (n=186)



Learning and Teaching with Maths Pathway

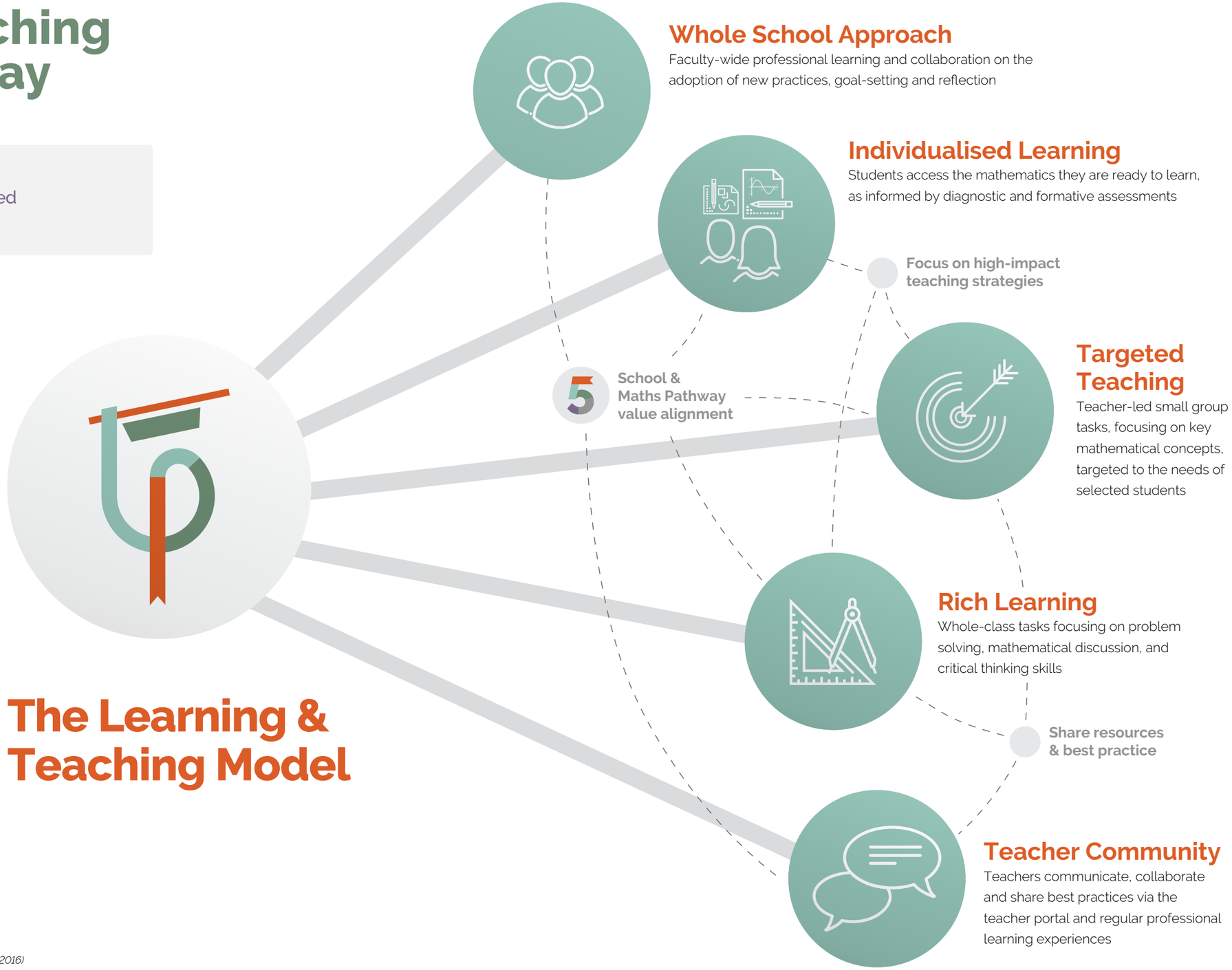
To address the challenges outlined in Section 2.0, Maths Pathway uses an approach that is underpinned by best practice in educational research.

The Maths Pathway approach encompasses three areas. The first area, as described in section 4.1, consists of a set of high-impact elements that are woven into the Maths Pathway Learning and Teaching Model. The elements include:

- Teaching at the point of need[16]
- Feedback, metacognition, and small group tuition[17]
- Rich, collaborative learning;[18] and
- Growth mindsets[19]

The second area is described in section 4.2. Given the importance of teachers in impacting student learning,[20] Maths Pathway provides teachers with a range of supports to help maximise that impact.

The third area described in section 4.3, focuses on the impact of school leadership,[21] and the specific set of supports provided by Maths Pathway at that level.



The Learning & Teaching Model

16 *(Goss, Hunter, Romanes, & Parsonage, 2015)* ***17*** *(Callender, Franco-Watkins & Roberts, 2016)*
18 *(Boaler, 2016)* ***19*** *(Dweck, 2006)* ***20*** *(Hattie, 2016)* ***21*** *(Contreras, 2016)*

4.1 Learning and Teaching Model

4.1.1 Model Overview

The Maths Pathway Learning and Teaching Model is an approach to structuring, teaching and learning mathematics.

Structuring: Each school term is typically structured to include four fortnightly learning cycles — each of which contains at least one whole class rich lesson — and a week-long rich project. Within each learning cycle different students are learning different mathematics, both individually, and in small teacher-led groups. Learning cycles conclude with a formative assessment that identifies which parts of the learning cycle's objectives have been achieved, and which are yet to be achieved. Preparation for the next learning cycle forms an important bridge, and includes student-led reflection, teacher feedback and goal-setting, along with an update to the student's learning profile based on data from the formative assessment.

Teaching: Teachers have access to student data, which informs how they can support student learning, and provide targeted instruction. The data provides visibility of what students are learning, what they can work on next, and automatically groups students who are ready to learn new concepts together. Teachers can then, for example, use this data to run small group tasks targeted to the needs of a specific set of students.

Learning: In addition to helping students develop their mathematical competencies, Maths Pathway strives to help students become good learners. The model is structured to provide opportunities for students to develop soft skills such as collaboration, self-regulation, creative problem solving, the ability to work to deadlines, and organisation. Discourse between students gives them the opportunity to articulate their mathematical ideas, challenge the thinking and logic of peers, and understand mathematics from another person's point-of-view. A focus on independent learning, as well as consistent reflection and goal-setting sessions, reinforces positive learning practices.

Parkdale Secondary College, Mordialloc VIC

> I have completely shifted from being a teacher-centred classroom to a student-centred classroom. This has been a revelation and made life a lot easier (my exit rate is down to almost zero). The students (ALL the students) are achieving and it's a pleasure to be in the classroom. I'm no longer running around re-explaining the same thing over and over again. Almost all other teachers have had a similar experience. Time pressures are no longer a problem. Students are achieving more in less time and we now have lots of time to concentrate on Problem Solving.
>
> **CHRIS HILL, NUMERACY COORDINATOR, EPPING SECONDARY COLLEGE, VIC**

> Now I have my finger on the pulse of every student. I know exactly what they are wanting to learn, what they would like to learn, and the direction their learning is going in. Sometimes they need some guidance as to where to go to next, but that is easy with Maths Pathway. I also get direction of the kids needs for mini-lessons. The learning is very student directed. My Maths Pathway partner [teacher] and I constantly talk about the program and the progress of our students. We are constantly excited about how much our students are achieving. We are seeing students who were disengaged now experiencing success. The lowest level student at the start of the year has grown two whole levels. We have filled the gaps in their learning and they are becoming more independent learners.
>
> **SUE CRICK, MATHS TEACHER, COLO HIGH SCHOOL, NSW**

> I started [Maths Pathway] at level six and I was really struggling, but now I can work level nine stuff really easily... I don't think I could have gone this far if I didn't do Maths Pathway. I think I'm around level 9.5, I can't do level ten stuff yet. I try doing it, but it's too hard for me. So I keep working on it, and I think I'll be able to do it in a little while.
>
> **FATIMA, YEAR SEVEN STUDENT, GLENROY SECONDARY COLLEGE, VIC**

4.1.2 Curriculum Rigour and Pedagogy

Learning materials in the Learning and Teaching Model are carefully constructed by the Maths Pathway Learning Team through a rigorous development and review process. All content is aligned to the *Australian Curriculum: Mathematics*, with teachers having visibility over how content connects to curriculum descriptors. In addition, the model has a strong focus on each of the proficiency strands: understanding, fluency, reasoning, and problem solving. In line with the recommendations of the National Research Council report *Adding It Up: Helping Children Learn Mathematics,*[22] the proficiency strands are interwoven and interdependent throughout all parts of the model.

Maths Pathway harnesses a powerful multi-modal approach of learning and teaching that ensures student success.[23] This includes individually-accessed learning activities, small group targeted instruction, and whole class rich learning tasks. Teachers also specifically aim to develop student learning skills and mindsets. The combination of these learning modes within the model means that students form deeper connections between mathematical concepts.[24]

Across all modes of learning, content is always targeted within each student's Zone of Proximal Development (ZPD) (Note 1). When working individually, students complete hand-written work, and are supported by both the teacher and peer tuition. The content is carefully scaffolded so that each question leads on to the next, helping them build new ideas from the mathematics they already know. This enables students to develop their understanding of mathematical representations, reflect on their work, and uncover misconceptions.

Small group targeted instruction is teacher-led and follows 'the gradual release of responsibility structure' (Note 2). Small group lesson plans that align to each key mathematical concept are included within the model. These tasks specifically provide a safe space for students to explore, question and make connections across the mathematical ideas that they have learned when working individually.

Rich lessons and projects see students come together for thought-provoking, teacher-led group activities with multiple entrance and exit points — accommodating the full range of student achievement levels. Rich learning encompasses the delivery of mathematics in a conceptual, open-ended manner, encouraging students to view problems through an exploratory lens.[29] During rich learning tasks students have time to think through the problem on their own before further exploration and sharing of ideas with peers. Through rich learning, students pull together learning from individual and small group work and make connections to mathematical ideas from across the curriculum.

Note 1 The Zone of Proximal Development:

Learning takes place when a student accesses work that is too difficult to complete automatically, but falls just within their reach with the right scaffolding.[25] To obtain deep understanding, students must actively construct their mathematical knowledge from existing knowledge,[26] rather than relying on memorisation techniques. This in turn requires a hierarchical learning paradigm where each piece of new learning has strict prerequisites that must first be met.[27] In other words, students can only conceptually understand a new piece of mathematics if they have already mastered everything that leads to that point.[28]

Note 2 The gradual release of responsibility structure:

***'I do'** - the teacher demonstrates the activity while the students observe and ask questions.*

***'We do'** - the teacher and student do the activity together.*

***'You do'** - the student completes the activity by themselves, while the teacher provides ongoing support as required.*

***22** (Kilpatrick, Swafford & Findell, 2001) **23** (Mourshed, Kreawitz & Dorn, 2017) **24** (English, 2002) **25** (Morgan, 2014) **26** (Walshaw, 2017)*
***27** (Jones & Russell, 1979) **28** (Vygotsky, 1978) **29** (Boaler, 2016)*

4.1.3 Improving student mindsets and motivation

When students are told they are performing poorly in mathematics class, they are more likely to be disengaged.[30] The Maths Pathway model provides teachers with the tools to overcome student disengagement and help students develop growth mindsets. In turn, students become more intrinsically motivated as they now have the opportunity to feel successful in mathematics.

The model helps teachers target content to the point of need of each student. Therefore, all students are able to grow and experience feelings of success in mathematics. As students learn with the Maths Pathway model, they are prompted to focus on their change of level rather than their absolute level. Their 'growth rate' is purposefully positioned as the key metric of success in the model, irrespective of a student's starting level.

Making student learning visible is conducive to the development of growth mindsets,[31] while also removing one possible cause for student disengagement. While this isn't a silver bullet for student engagement and mindsets, it has a positive effect; particularly when combined with purposeful teacher practice.

> Students with low engagement are enjoying mathematics. We are finding students who have behaviour problems in other learning areas are fine in maths class. I've had more time to work one-on-one with students at all ends of the spectrum, instead of just focusing on those students who were struggling. In particular our top students have enjoyed being able to move at their own pace. In terms of teacher prep I've found I've had more time for planning rich learning rather than just marking.
>
> **KATIE BROOKS, DEPUTY PRINCIPAL AND MATHEMATICS TEACHER, CHRISTMAS ISLAND DISTRICT HIGH SCHOOL, WA**

St Mary's Catholic Primary School, Whittlesea VIC

***30** (Goss & Sonnemann, 2017) **31** (Dweck, Walton & Cohen, 2014)*

4.2 Supporting teachers

The impact that teachers have on student learning cannot be understated. Hattie's meta-analysis from 1200 studies has found that collective teacher efficacy has an effect size of 1.57 on student learning,[32] (see section 5.3). Collective teacher efficacy refers to the belief within a school that teachers have a strong influence on student achievement, and that they work together to overcome any behavioural, motivation, or learning problems of their students. Teachers in these schools also share a culture of innovation and a commitment to improving their practice.[33] The Maths Pathway Learning and Teaching Model has been architected to enable teachers to focus on practices with the greatest impact on students.

4.2.1 Actionable Data

Having access to data on students' learning is vital to effective teaching, but also difficult to come by. In a typical mathematics class, where student data is collected manually, challenges exist in making effective use of that data. In addition to the workload of administering assessments, the amount of time required to analyse the data makes it difficult for teachers to use it to inform their practice in a meaningful way. By contrast, when using Maths Pathway the data is collected and analysed automatically, within a structure where it can be used productively.

To deliver targeted instruction to every student it is necessary to first exactly understand a student's learning up to now. In the Maths Pathway model, this is achieved with an initial diagnostic process that determines the gaps and competencies that students have across the entire mathematics curriculum, from level 1 through to level 10A. This evidence is used to form a learning profile for each student and provide point-of-need instruction on a continuous basis. This data is used daily by teachers to inform their practice and student interventions including: one-on-one feedback sessions, the structure of small group lessons, and key mathematical concepts a teacher should focus on with each student. Data on student capabilities and growth is tracked, giving teachers exceptionally detailed information on all their students. Having this data available at all times makes continuous reporting, end-of-semester reporting, and communication with parents simple.

PATH17 Teacher Conference, Lancefield VIC

> My students are always keen to start their work each lesson. The level of engagement is very high. Sometimes I think the kids are off-task talking, but then I find they are actually discussing or arguing over maths questions. Before Maths Pathway tests were to be feared, now tests are opportunities to grow. One girl who started at level 3.71 has just achieved 5.76. She is amazing! I am really impressed with their conceptual knowledge and how it impacts the way they answer questions. I think that success can be measured in engagement, enjoyment and growth. The most successful students were those who really wanted to learn. My role is always to motivate.
>
> **SUE CRICK, MATHEMATICS TEACHER, COLO HIGH SCHOOL, NSW**

> We are still battling years of ingrained static mindsets, and building the growth mindset has been the most difficult challenge this year. It has been exciting to see the students understand and have a metric for measuring their growth. Many of them have started to have their view of maths demystified, largely due to the fact that each skill is taught step-by-step and in a logical sequence, so that nothing seems foreign or strange to them. I feel like some of the greatest results have been among those students for whom maths has always seemed terrifying and beyond them. They finally start to realise that not only can they do it, but also that their futures could include maths — and they would be fine with that.
>
> **GERRARD HERPICH, LEARNING SPECIALIST, NORTHERN BAY COLLEGE, TALLIS P-8, VIC**

> A colleague ran Year-To-Date behaviour management statistics for our school, and compared them to last year. In 2016 we piloted Maths Pathway near the end of the year, and in 2017 we have 520 students on Maths Pathway out of a total cohort of 1200. Behaviour reports by the maths faculty dropped by 40%. All my teachers know exactly why — the students are more engaged.
>
> **MICHELLE FRY, HEAD OF MATHS, REDCLIFFE STATE HIGH SCHOOL, QLD**

32 *(Hattie, 2016)* ***33*** *(Tschannen-Moran & Barr, 2004)*

4.2.2 Building teacher capacity through professional development

As noted earlier, teachers are the drivers of student success in the mathematics classroom, and the greatest source of variance that can make a difference for student learning outcomes.[34] To support teachers as they manage the complex challenges of their role, The Maths Pathway model incorporates strategies to help them build their capacity with forums for collaboration, and the delivery of ongoing professional development. Through these initiatives teachers can build their pedagogical content knowledge (to understand the most powerful explanations, tools and analogies that can be used to teach mathematics), and pedagogical knowledge (the principles of teaching).[35]

All Maths Pathway teachers engage in professional learning that incorporates best practice research on teaching mathematics, teaching students at their point of need, developing growth mindsets, and building motivation among students.

The Maths Pathway professional development program has online and face-to-face components, which are designed to facilitate personal reflection as well as discussion and collaboration with colleagues:

- Two-day 'train-the-trainer' retreats for new schools
- Ongoing online training for all Maths Pathway teachers
- Regular and structured meetings for Maths Pathway school leaders and teachers
- Annual PATH conference, where Maths Pathway teachers come together to share best practice

Since the introduction of the 'train-the-trainer' retreats at the end of 2015, 561 teachers have participated in these events. The retreats are highly effective at introducing new teachers to the model; in 2017, 90 percent of teachers walked out satisfied and willing to recommend the retreat to others (Table 1). In addition, the recommended in-school training (led by the teachers who attend the retreats) has been accessed by 2,082 teachers. This teacher-led approach empowers schools to tap into the collective knowledge of the Maths Pathway community and increase the effectiveness of their mathematics faculty over time. Teachers have access to a wealth of experience and helpful case studies through their Maths Pathway Consultants, both at the trainer retreats and in an ongoing manner to support their implementation.

TABLE 1
2017 TEACHER RESPONSES TO TRAINER RETREAT (n=221)

Survey item	Teacher rating out of 100%
Overall, how satisfied were you with the event?	90%
I am 100% confident using the system	76%
I am 100% confident to lead a PD program at my school	76%
I have a concrete change management plan to take back to my school	79%
I feel like I am part of the Maths Pathway Community	86%
How well did our facilitator's do?	92%
How likely are you to attend another one of our events?	79%
How likely is it that you would recommend this event to a friend or colleague?	89%

In 2018, elements of the trainer retreat have been restructured to support teachers to become more confident using the model, to be more confident leading the professional development program for their colleagues, and to ensure they have a robust change management plan in place.

> The facilitators were very confident and had strong knowledge of the program and its implementation. They also had lots of experiences they were able to share.
>
> **TRACIE BAKER, LEADING TEACHER - NUMERACY, SEYMOUR COLLEGE VIC**

> The two days went by quickly and everything we covered was relevant, I honestly can't think of a session where I was disengaged. I enjoyed the final session as it allowed me to focus on our school's situation and brainstorm strategies for dealing with potential issues.
>
> **KON KRITIKOS, MATHS TEACHER, FAIRFIELD HIGH SCHOOL NSW**

Teacher Professional Development Retreat, Lancefield VIC

34 *(Hattie, 2009)* ***35*** *(Shulman, 1986)*

4.3 Supporting schools

Like collective teacher efficacy, effective school leadership has a considerable impact on student achievement.[36] It is therefore critical that principals have the tools to help them provide strategic direction to their faculties and school community.

4.3.1 Strategic resources and insights

All Australian schools are required to report on student data throughout the year to a range of internal and external stakeholders. Many schools only have the capacity to generate student progress reports each term. Data for these must be collected, formatted, and analysed manually. Conversely, with Maths Pathway, teachers and leadership have access to inbuilt continuous reporting features. Reports can be generated on demand, providing exceptional visibility over student outcomes, and enabling consistent reporting structures and templates to be used by all staff.

Schools that partner with Maths Pathway also benefit from easier communication between the mathematics faculty and parents. A built-in parent portal contains automatically updated information on each child's learning; which schools can customise to suit their context, ensuring that the messaging is well tailored to the local parent community. Presented with this data, parents are able to see their child's progress and engage meaningfully in their mathematics education.

Supporting the work of school leaders, who view the data through a macro lens to understand trends and patterns across cohorts of students, is imperative. Dedicated Maths Pathway School Consultants engage in proactive data monitoring and regular communication with schools about their results. In addition, the Consultancy team is available to help principals and teachers meet the individual reporting requirements of each state.

4.3.2 Collaborative learning within a faculty

The professional development component of the Maths Pathway model (see section 4.2.2) encourages teachers within a faculty to collaborate while they adopt new practices, reflect on and set goals for their own practice, and learn from each others' experiences. In addition to benefiting new and experienced mathematics teachers, professional development enables out-of-field teachers to receive valuable support.

With approximately 40 percent of Year 7 to Year 10 mathematics classes taught by teachers who are not trained in mathematics,[37] it is imperative for school leaders to provide support to their out-of-field teachers. Maths Pathway provides the framework to ensure all teachers are well supported to adopt effective practices, while simultaneously building their pedagogical content knowledge.

4.3.3 Student transitions

The effect of a great teacher can be lost when a student moves classes or changes schools.[38] Studies have shown that the disruption to routines and established relationships as students move between schools, or transition from primary to secondary school, can have a negative impact on student learning.[39] However, the 'transition dip' from Year 6 to Year 7 can be resolved by "access to high quality, accurate information."[40]

When students transition between Maths Pathway schools, including from Year 6 to Year 7, their data transitions with them. This means that teachers have the benefit of highly detailed data on their students' mathematics history as soon as they join the class. Student familiarity with the Maths Pathway model is an additional benefit, because they understand the routines and learning expectations, thus minimising the disruption that may otherwise occur.

> As an out-of-field math teacher, I was really nervous about maths. It was my least favourite subject to teach and I think previously, that showed a lot. The kids would do the work, and I would mark the work, but there wasn't necessarily that fun and the connection with mathematical thinking. Maths Pathway has changed that for the better. Now I really enjoy teaching maths, and I feel I'm learning all the time. I've got one student who is well ahead, but there are all the resources in Maths Pathway to make sure that I'm scaffolding him in the best way that I can. I love that because previously I would have said, "Oh, I'm not really sure what to do with you." In the best way possible I would have tried, but I like that there's a resource that helps me do it properly.
>
> **REBECCA BLAND, PRIMARY SCHOOL TEACHER, WOODLEIGH SCHOOL, VIC**

> Prior to Maths Pathway, you'd sit down with the teacher from the year before, and the primary school would do a handover of the students. It would typically be a behavioural kind of handover, and whether they are at standard in math. But you would never talk through all 12 sub-stands of math and say, "Hey, they're weak in this, they're strong in that." There was never that level of data, whereas now, we can see that. In Maths Pathway, from a handover point of view from Year 5 to Year 6 to Year 7, whatever, you get a graph that shows their growth in the prior year. You can go back and look at what areas of math that they were weak in and strong in. There's no way in written language that a person could hand over that sort of richness of data. So, it informs us much more accurately as to the abilities and the needs of our students, and we can then work better with them as the years go along.
>
> **NEIL MCANDREW, MATHS TEACHER, GILSON COLLEGE, VIC**

> We were looking for a way to personalise maths, because it is one of the subject areas where you can have a really large range of student ability in every classroom. Over the years, there have been lots of computer-based programs — we have used some of those in the past. Maths Pathway was the first one that really diagnosed where students were sitting at the moment, and then built the learning around what they know and where they want to go with their learning. The assessments mean that the teachers have, at the end of every two week period, a really good snapshot of where the children are at, and where the children across the whole year are at. The teachers have great control, because of the information and reports that they receive, and the parents know exactly where their child is at all the time.
>
> **PHILLIP SMITH, PRINCIPAL, ST MARY'S PRIMARY SCHOOL WHITTLESEA, VIC**

36 *(The importance of leadership in high-performing schools, 2012)* ***37*** *(Office of the Chief Scientist, 2014)* ***38*** *(Siennick, 2017)*
39 *(Lou & Rickard, 2016)* ***40*** *(Siemon, 2001)*

The impact of Maths Pathway in 2017

This section compares student achievement data from typical classrooms to their achievement and growth when they learn with Maths Pathway. The data was collected through Maths Pathway's online assessment system. This system has a much higher degree of granularity — and much more complete coverage — than any other widespread Australian mathematics assessment tool.[41] See section 8.0 for detailed data methodology.

The measurement approach used by Maths Pathway has been constructed to evaluate impact on student learning outcomes and for the purpose of targeting teaching to point of need. Knowing a student's overall level of achievement is not enough to achieve this aim, because two students sitting at the same overall level can have very different learning needs. Instead, Maths Pathway gathers data directly on each distinct learning objective across the entire curriculum, spanning levels 1 to 10A; without relying on statistical inference. This data makes it possible to determine the set of learning objectives which sit within each individual student's ZPD.

Examination of Maths Pathway data on student achievement yields insights that are shared in this section. Where possible, analysis has also been done to understand the impact of Maths Pathway for those students who are typically under-served in mathematics education in Australia. Given the availability of data on school ICSEA levels and students' gender, insights from analysis of these demographics have been included. Each finding is explained in greater detail in sections 5.1 through to 5.5.

> I feel strongly that something like the Maths Pathway diagnostic, which assesses every single progression point and gives you a mark for each progression point is a much better way of deciding where someone is on a continuum, than 30 questions adaptively on an on-demand test, or 40 questions over an hour in NAPLAN. So personally, I feel that the Maths Pathway data is better than anything we've had before, and if we're given a tool that's better than anything we've had before, then we should use it.
>
> **LACHLAN CHAMPION, HEAD OF MATHS & NUMERACY (2017), BRIGHTON SECONDARY COLLEGE, VIC**

41 *(Pearson, 2017)*

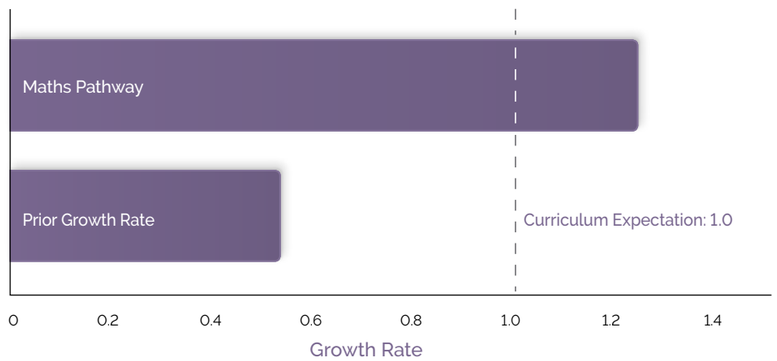
5.1 Students in Maths Pathway partner schools learn twice the amount that they would in typical classrooms

For every year of schooling, students are expected to learn one year's worth of mathematics.[42] However, it is evident that on average students do not achieve this. Siemon et al.'s *'Middle Years Numeracy Research Project: 5-9'* found that the average Year 8 student is several years behind the year level standard.[43] The implication of this is that most of these students are not achieving the expected rate of growth, indicating that progress is much less than one year of learning per calendar year.

A similar estimate has been attained by performing the same calculation with Maths Pathway entry point data across 22,064 students in 2017: a mean of 0.54 levels of mathematics learned in each prior year of schooling. 'Prior growth rate' is measured by taking a student's diagnosed level when they begin using Maths Pathway and averaging it over the number of years they have attended school (Note 3). In the interests of estimating the impact of the Learning and Teaching Model conservatively this is a best-case estimate of prior growth, because it assumes that students learn all of their mathematics at school, and none prior to starting school. In reality, prior growth rates are probably lower. For more information on the data methodology used, see section 8.0.

In contrast, when using Maths Pathway, students' average growth rate exceeds one year's worth of mathematics per year. Analysis of data from formative assessments for Year 5 to Year 10 students during 2017 indicates that the average growth for Maths Pathway students was 1.25 levels per year. This is over twice the amount of the estimated 0.54 levels students gain in typical Australian classrooms.

FIGURE 7.
GROWTH RATE IN MATHEMATICS (n=22,064)



Note 3 **Measuring student growth rate**

Student growth rate refers to academic progress made over a defined period — the amount of new mathematics that a student learns in that period, expressed as a proportion of the average amount of new mathematics a student would need to learn every year between Year 1 and Year 10, in order to have mastered all of the mathematics content and skills up to and including the end of Level 10 by the end of Year 10.

42 *(Hattie, 2016)* ***43*** *(Siemon, Virgona, & Corneille, 2001)*

The change between an individual's growth rate prior to using Maths Pathway and their growth rate with Maths Pathway can be described by the term 'improvement factor' (Note 4). This refers to the individual (as opposed to average) change in performance for a given student. For example, a student who was previously learning 0.4 levels of mathematics per year but then began learning 0.8 levels of mathematics per year with Maths Pathway, has an improvement factor of 2. Any improvement factor that is greater than one means that the student made more progress in the Maths Pathway model than they did previously. Of 22,064 students using Maths Pathway in 2017, 98% had an improvement factor greater than one. The mean improvement factor across all these students was 2.71. Note, because this number represents an average of the relative improvement of each individual student, it is different to the difference between the pre- and post-Maths Pathway growth rates of 0.54 and 1.25, which are concerned only with the relative improvement of the average student.

Note 4 Measuring improvement factors

The improvement factor for an individual student is determined by calculating the ratio between that student's present growth rate and their growth rate prior to using Maths Pathway.

> The majority of students are more engaged, confident and productive. As these students move into higher year levels (especially years 11 & 12) I expect we will see a pursuit of maths and success in maths from a wider range of students than we have had previously. I also expect that we will see students who pursue a trade feeling more confident in their maths.
>
> **ROSE NIHILL, MATHS TEACHER, ST MARY OF THE ANGELS NATHALIA, VIC**

Redcliffe State High School, Redcliffe QLD

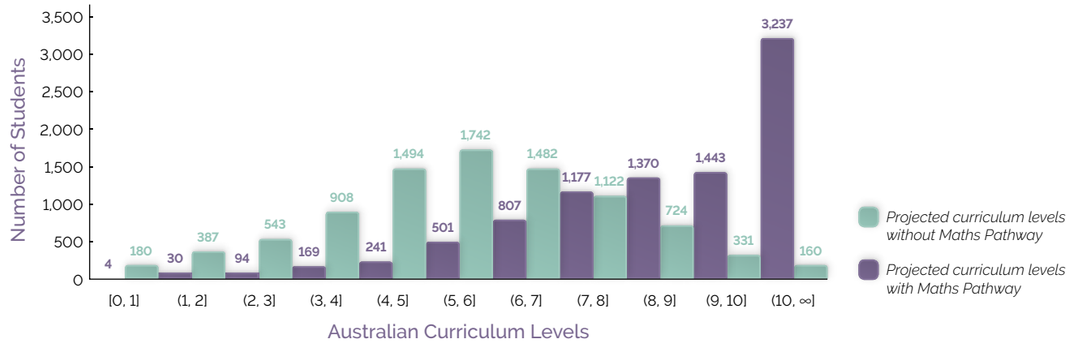
5.2 Projected learning outcomes of Maths Pathway students

Where students end up at the conclusion of Year 10 is important, as it provides an indicator of what mathematics and STEM-related pathways they will be able to access, and how numerate they will be throughout their lives.

The estimated curriculum levels that 9,073 Year 7 students in 2017 would reach by the end of Year 10 without Maths Pathway, are illustrated in Figure 8. Only 1.7% of these students (160 out of 9,073) would be projected to attain level 10 of the curriculum or higher by the time they complete Year 10. This suggests that many students would not be sufficiently prepared for continuing with mathematics in the senior years of secondary school. However, when students improve their growth rate, this impacts their level of achievement over time.

The trajectories of those same students are also illustrated in Figure 8, based on their growth rates with Maths Pathway. This figure highlights that over 35% of students (3,237 out of 9,073) are projected to be at or above curriculum level 10 by the end of Year 10 when using Maths Pathway. While all students would ideally be at this level, the data suggests that with Maths Pathway students are better prepared for continued mathematics studies in Year 11 and beyond.

FIGURE 8
PROJECTED LEARNING OUTCOMES IN MATHEMATICS (n=9,073)



> I've got reams of data, graphs and other evidence to show how our top kids are really excelling here at Brighton. A colleague and I were just discussing our first Year 7 to clock the system this week — any student who arrived in High School over two years ahead could never have made another two years' progress in the time before we used Maths Pathway! At the beginning of Year 7 in 2016, we had only five kids who were more than six months ahead of the standard; now in Year 8 we have 41 (and half a dozen finished level 10). I've also got On Demand Testing data which shows a 70% correlation with Maths Pathway scores.
>
> **LACHLAN CHAMPION, HEAD OF MATHS & NUMERACY (2017), BRIGHTON SECONDARY COLLEGE, VIC**

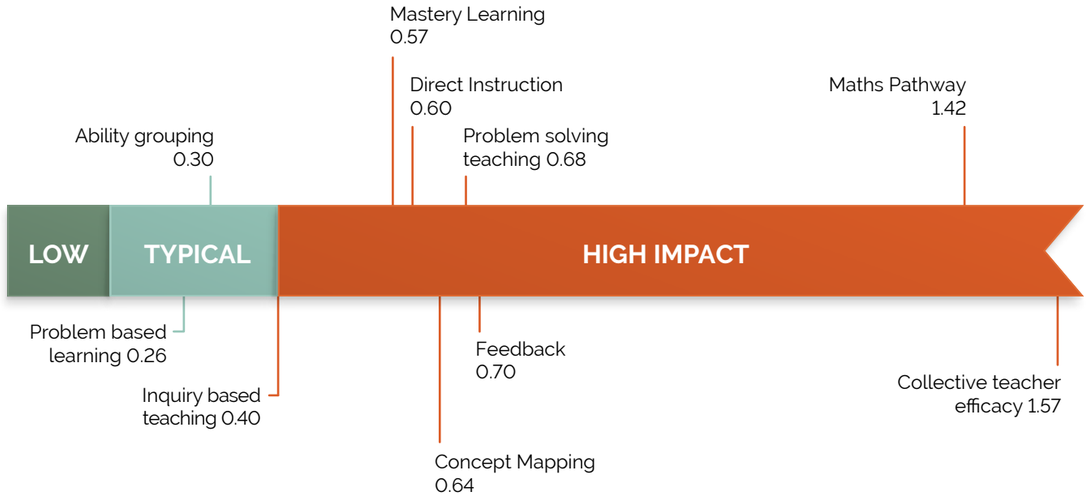
De La Salle College, Malvern VIC

5.3 Maths Pathway has an effect size of 1.42 on student learning outcomes

The influence of Maths Pathway on student learning outcomes has been calculated by comparing the progress that students make when they use the model, and their progress in a typical classroom. Section 5.1 showed that before they began learning with Maths Pathway, students were learning a mean of 0.54 levels of mathematics in each prior year of schooling. In comparison, the growth rate of students learning with Maths Pathway in 2017 was 1.25 levels of mathematics, for each year of schooling.

Using these two data points, an effect size can be calculated to indicate the impact that Maths Pathway has for students (Note 5). According to Hattie's method of calculation, that effect size is 1.42 — putting the Maths Pathway Learning and Teaching Model within the band of 'high impact' teaching strategies (Figure 9).[44]

FIGURE 9
MATHS PATHWAY'S EFFECT SIZE[45]



Range of effect sizes by colour

44 - 46 *(Hattie 2009)*

Note 5 Measuring effect size

Effect size is a way of evaluating the impact of an educational approach or intervention. It is calculated by dividing the difference in the means of a control group and a 'treatment group', by the pooled standard deviation of the samples. For example, an effect size of 1.0 tells us that the means of the two groups differ by a standard deviation, representing what's considered a large effect size. The average effect size in educational research is 0.4. Effect sizes less than 0.15 are considered small, and interventions with effects greater than 0.4 fall within the "zone of desired effects".[46]

5.4 Maths Pathway students from low ICSEA backgrounds have dramatically improved opportunities for success

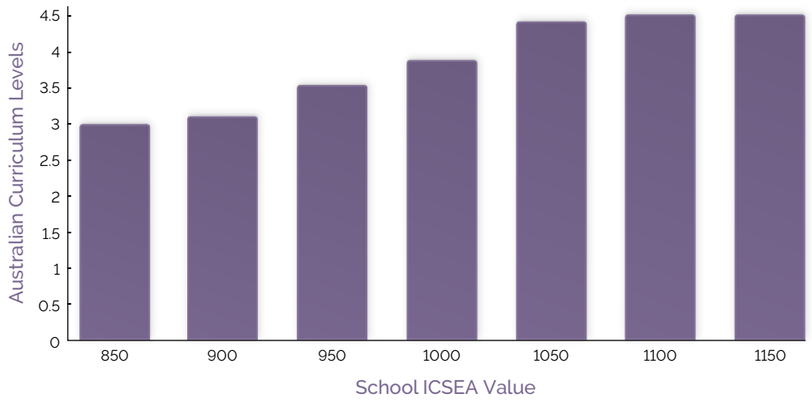
The achievement levels of students from low ICSEA backgrounds are typically lower than their more advantaged peers.[47] However, it is possible for students from disadvantaged backgrounds to overcome adversity to achieve academic success, defined by the Organisation for Economic Co-operation and Development (OECD) as 'resilient students'. Between 2006 and 2015, PISA data tracked the share of resilient students across 51 countries. Australia was one of nine countries where the resilience of disadvantaged students decreased.[48] Furthermore, the equity of Australian schools has declined since the Gonski Review of Funding For Schooling in 2011, and in 2016 the Centre for Policy Development found that "A child's background is having a greater impact on their ability to succeed at school."[49]

Maths Pathway diagnostic assessments reflect this trend. Figure 10 shows that the average diagnosed level of Year 7 students in 2017 increased as their school's ICSEA level increased.

Maths Pathway helps address this inequality. When low ICESA schools (below 1000) implement Maths Pathway, the mean improvement factor for students is 3.11, which is even greater than the mean improvement factor of 2.71 for all students (see section 5.1). For students in low ICSEA schools, this means that they are learning 3.11 times the amount of mathematics they were prior to commencing Maths Pathway, providing them with the opportunity to overcome socio-economic disadvantage.

FIGURE 10

DIAGNOSED LEVEL OF YEAR SEVEN STUDENTS, CLASSIFIED BY ICSEA (n=9,042)



47 *(Wienk, 2017)* **48** *(Agasisti, Avvisati, Borgonovi & Longobardi, 2018)* **49** *(Bonnor & Shepherd, 2016)*

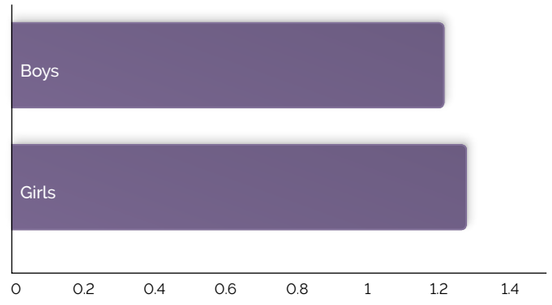
5.5 Girls are more successful with Maths Pathway

According to Cole et al. boys consistently outperform girls in mathematics, particularly in high-ICSEA schools and in the top bands of NAPLAN. In the early years of schooling the gender divide is minimal, however by Year 8 a clear gap develops that continues to increase throughout the later years of schooling. This problem is compounded by the number of students not choosing to pursue senior mathematics across the board, as the rate of declining enrollments into senior mathematics is greater for girls.[50]

The Maths Pathway Learning and Teaching Model is helping to address these trends. The average growth rate for girls using Maths Pathway in 2017 was 1.28, higher than the average growth rate of 1.22 for boys (Figure 11). By experiencing greater success in mathematics, girls are beginning to close the achievement gap.

FIGURE 11.

COMPARISON OF MEAN GROWTH RATES IN MATHS PATHWAY, BY GENDER (n=23,915)



Given the sample size the difference between the mean growth rates for boys and girls using Maths Pathway is statistically significant (p=<0.01).

50 *(Cole, Jane, Suggett, & Wardlaw, 2016)*

Implications for systemic change

As education researchers Bentley and Savage have noted, "the future success of Australian school education hinges on whether powerful ideas can be realised in practice, across tens of thousands of classrooms and communities".[51] To meet this need, Goss has suggested six ways in which Australia's education system can become more adaptive (see Note 6).

Maths Pathway is committed to improving the educational outcomes of the greatest possible number of Australian students, and reaching beyond individual classrooms to affect change at a system level. The following section discusses how the Maths Pathway Learning and Teaching Model is a solution that can help Australia move towards a more adaptive education system.

The model is successfully harnessing technology to deliver differentiated content at scale, and is continuously measured and evaluated to ensure its ongoing efficacy. The network of Maths Pathway partner schools enables teachers to share information and best practice — presenting a unique opportunity to help Australian schools consistently implement high impact teaching strategies.

The adoption of any educational reform at a national scale requires robust change management strategies. By not successfully addressing the multi-faceted nature of change within schools, as well as the complexity of the system as a whole, many previous initiatives have failed.[53] A range of comprehensive change management resources and strategies are built into the model (Note 7), which have been developed in consideration of the unique challenges faced by schools, as well as the influencing factors within each state. The School Consultancy team helps teachers execute these strategies, ensuring schools are fully equipped to implement Maths Pathway, with a smooth transition for the faculty and students alike.

The Maths Pathway model is adaptive to the contexts of individual schools, while also remaining sufficiently consistent for schools to learn from practices across the entire network. Over time, Maths Pathway has developed a deep understanding of how to overcome the challenges schools face, and how to best support teachers leading the change.

Note 6 **Goss' six criteria to move towards an adaptive education system in Australia.[52]**

- *Policy makers need to change the way they think about system leadership. In an adaptive education system, the ultimate role of the centre is system design*
- *Teachers and school leaders should do more to embrace the benefits that come from standardising elements of teaching practice*
- *Australia should make better use of its most expert teachers, using them to teach other teachers and spread evidence at scale*
- *We need to continue building better ways to spread and share information and practices, both within schools and across schools*
- *Teachers and schools must be better able to track the progress of their students over time in ways that directly inform their teaching*
- *Schools and systems need to innovate more systematically and intentionally to prepare their students for a changing world*

De La Salle College, Malvern VIC

As more schools partner with Maths Pathway, the collective knowledge and practices from the teacher community continues to grow and be refined over time. The continuous measurement of student data means that systematic innovations can be made to the model, to ensure that it remains at the forefront of best-practice in mathematics education. Maths Pathway is a solution with measurable impact, capable of effecting sustainable change on a macro scale: Every student, irrespective of their starting point, can experience success in mathematics, at school and beyond.

Note 7 **Maths Pathway change management process**

- *When schools choose to implement the Learning and Teaching Model, Principals and Maths Pathway representatives sign a document to signify that they are aligned to a common set of values*
- *Change leaders attend a two day 'train-the-trainer' retreat, where they learn the skills to train their peers and successfully roll out the model at their own school*
- *The entire faculty is able to up-skill with ease through ongoing online and face-to-face professional development opportunities*
- *Inter-school networking, and ideas and resource sharing is facilitated through the Maths Pathway teacher community*
- *A dedicated team of Maths Pathway School Consultants provide hands-on support and advice, tailored to each school*
- *School leadership commits to teaching mathematics with Maths Pathway, rolling out the model cohort by cohort*

51 *(Bentley & Savage, 2017)* ***52*** *(Goss, 2017)* ***53*** *(Cornu, Peters, Foster, Barratt, & Stratfold, 2006)*

SECTION
7.0

Growing our impact together

The year 2017 has, in many ways, been a momentous one across the world. Many of the old systems (of politics, economics and society) have been put under considerable strain. Our education system has not been immune to this pressure. Much has been said and written about the declining results of Australian students, the ongoing underrepresentation of women in the STEM fields, and the socioeconomic inequity reflected in the results of Australian students. Now, more than ever, our systems (and all the players within them) need to step up to the challenge of preparing our students to both meet, and challenge, the world around them.

We believe the future of mathematics education in Australia is a bright one. As a country, we have the potential to lead the way in developing the intertwined skills of critical thinking, reasoning, computational thinking, statistical literacy and numeracy. We can create generations of children who are not simply numerate, but appreciate the joy and utility that an excellent mathematics education brings, and who become the most sought after employees, entrepreneurs, thinkers, politicians and leaders in the world.

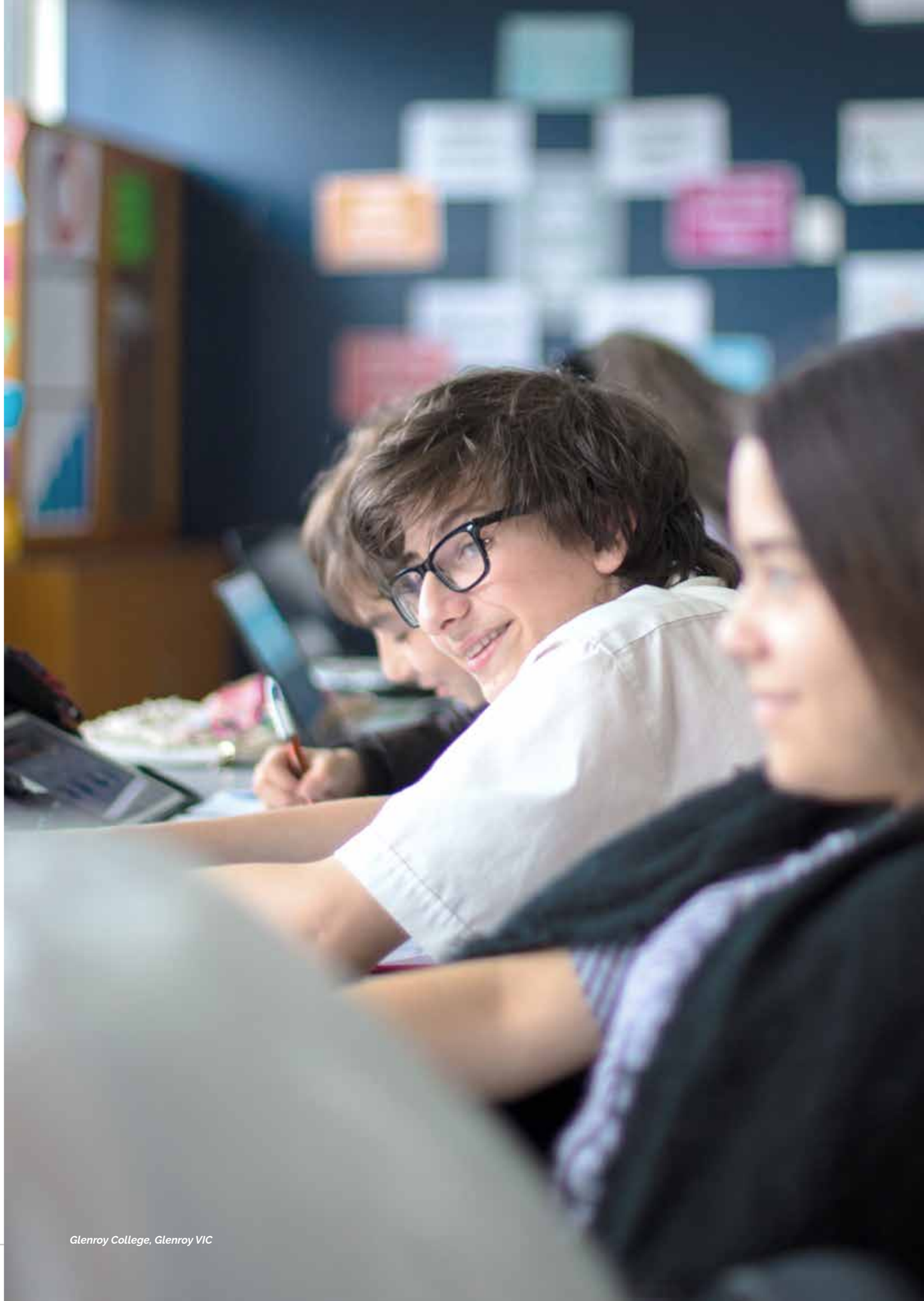
That is the kind of world we want to live in, and this is the promise that we as the Maths Pathway community make to all of you: we will never rest until we live in that world.

In realising this vision, we must work in partnership with each one of our schools, teachers and students. Over the last four years, Maths Pathway has become the most effective framework for scaling excellence in mathematics education – and we're not done yet. In 2018 we will continue to innovate the model and focus on bringing a genuinely rich learning experience to every mathematics classroom. We'll be working with both students and teachers to develop and optimise that experience, and we plan to have 100,000 students thriving in the model by the end of the year.

To every Maths Pathway student, teacher and school leader: it is your work in 2017 that has created the results reflected in this report. Each one of you represents an element of the single most important part of our society: our education system. The team at Maths Pathway will continue to grow and support you over 2018 and beyond, and we cannot wait to grow our impact together.

To every other student, teacher and school leader in Australia: what are you waiting for?

RICHARD WILSON
Co-founder, Chief Visionary
Maths Pathway



Glenroy College, Glenroy VIC

Data methodology

In Australia, tools commonly used to examine a student's level of achievement in mathematics include the National Australian Program — Literacy and Numeracy (NAPLAN);[54] the Progressive Achievement Test in Mathematics (PAT-M);[55] and the On-Demand Testing Program.[56] All three employ a specific type of Item Response Theory called the Rasch Model.[57] In this approach, a specially constructed test is administered to a student, and the number of correct responses is counted. This provides a measurement of the student's 'latent trait', which can be thought of as their overall position on a continuum, along with a margin of statistical error. The statistical model allows this to be done using a relatively short test (say, 40 questions).[58]

The measurement approach used by Maths Pathway is fundamentally different, because it is constructed for a very different purpose: to target teaching to point of need. Knowing a student's overall level of achievement (with or without statistical error) is not enough to achieve this aim, because two students sitting at the same overall level can have very different learning needs. Instead, Maths Pathway gathers data directly on each distinct learning objective across the entire curriculum, spanning levels 1 through to 10A, without relying on statistical inference. This data makes it possible to determine the set of learning objectives which sit within the individual student's ZPD, but necessitates a much longer test (typically hundreds of questions long). In practice, students complete this diagnostic assessment in multiple sessions spread out across a semester; and adaptivity which leverages non-statistical inference keeps the test length to a manageable size (using the set of known clear relationships between connected learning objectives; for example, single-digit addition and multi-digit addition).

The result is a detailed learning profile for each student. That profile consists of a vast number of learning objectives, arranged into distinct levels following the structure of the *Australian Curriculum: Mathematics*. For each learning objective for each student, there exists evidence to show either that they have, or have not yet achieved the objective. This learning profile is updated each learning cycle — typically 16 times per year — to include the updated direct evidence of what the student has achieved.

It is worth noting that this approach amounts to 'criterion reference' measurement, which has been suggested as a more suitable approach than the Rasch Model for educational measurement because it does not rely on an assumption of 'unidimensionality of ability'.[59] This assumption is that there is only one underlying trait which determines a student's response to assessment items; rather than one trait governing algebraic item responses, and another trait governing geometric item responses for example. Despite having no unidimensional latent trait, Maths Pathway learning profile data can be abstracted down to a single 'overall level number', as a function of ACARA's arrangement of learning objectives into a level structure in the *Australian Curriculum: Mathematics.*

This overall level of achievement is derived by summing the proportion of learning objectives which have been achieved at each level. This accounts for both gaps from lower levels, and competencies from higher levels. This means that the overall level of achievement increases whenever the student learns something new.

54 *(Australian Curriculum, Assessment and Reporting Authority, 2018a)* ***55*** *(Australian Curriculum, Assessment and Reporting Authority, 2018c)*
56 *(Victorian Curriculum Assessment Authority, 2018)* ***57*** *(Rasch, 1980)* ***58, 59*** *(Goldstein, 1979)*

8.1 An explanation of the data analysis within this report

In 2017, there were 35,397 students using Maths Pathway. Not all of those students, however, have been included in every mean or distribution calculation. In general, only students with data that is sufficiently 'complete' from the whole year are used. This equates to 25,860 students (or 73% of the total population of Maths Pathway students).

The following section breaks down the analysis performed on Maths Pathway data, in order to calculate the key findings within this report.

Diagnosed level

The diagnostic assessment that every student undertakes when they begin using Maths Pathway establishes their achievement level in line with the *Australian Curriculum: Mathematics*. Year 7 students in 2017 who had sufficiently complete data were used in the measurement of this metric, equating to a total of 9,073 students. When considering students from low ICSEA backgrounds the number of students measured was 9,042, as a small number of schools do not have ICSEA data and are therefore excluded.

Measuring growth rates

Student growth rate refers to academic progress made over a defined period — the amount of new mathematics that a student learns in that period, expressed as a proportion of the average amount of new mathematics a student would need to learn every year between Year 1 and Year 10 in order to have mastered all of the mathematics content and skills up to and including the end of level 10, by the end of Year 10. Prior growth rate is measured by taking a student's diagnosed level when they began using Maths Pathway and averaging it over the number of years they have attended school. Note that in the interests of estimating the impact conservatively this is a best-case estimate of prior growth, because it assumes that students learn all of their mathematics at school, and none prior to starting school. In reality, prior growth rates are probably lower.

Effect size

Effect size is a way of evaluating the impact of an educational approach or intervention. It is calculated by dividing the difference in the means of a 'control group' and a 'treatment group', by the pooled standard deviation of the samples. For example, an effect size of 1.0 tells us that the means of the two groups differ by a standard deviation, representing what is considered a large effect size. When calculating effect size, the 'control' group refers to the growth rate of students in Maths Pathway schools if they had continued to grow at the rate they were growing prior to using Maths Pathway, and the 'treatment' group refers to the set of Maths Pathway students in 2017. The average effect size in educational research is 0.4. Effect sizes less than 0.15 are considered small, and interventions with effects greater than 0.4 fall within the "zone of desired effects".[60]

60 *(Hattie 2009)*

Improvement factor

The improvement factor is calculated by measuring the change between an individual student's present growth rate and their growth rate prior to using Maths Pathway. In calculating improvement factor, 3,796 students (14.7% of the sample with sufficiently 'complete' data) were excluded from the sample because their prior growth rate could not be accurately calculated due to incomplete diagnostic data. This is largely because those students had started with Maths Pathway late in the year, and did not have sufficient time to complete their diagnostic assessments.

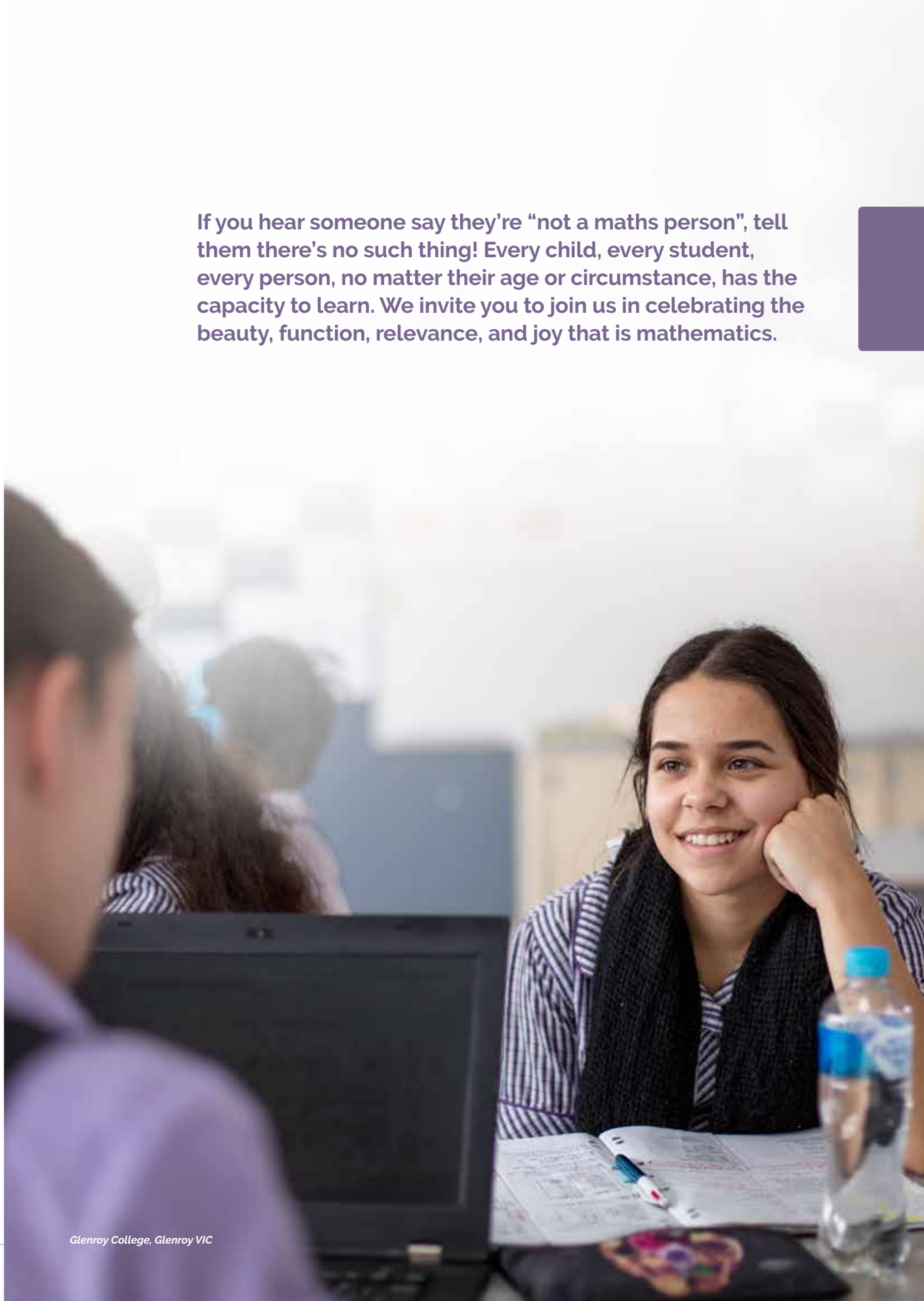
Comparing student growth according to gender

When comparing growth rate by gender 23,915 students were measured (92% of the sample with sufficiently 'complete' data). This figure is smaller than the sample because Maths Pathway allows student genders to be marked as male, female, other or unknown. For this comparison only students whose gender was known to be male or female were included.

8.2 Other methodological questions

For the sake of brevity, some elements of the data collection and analysis methodology used for this report have been excluded. These include the strengths and limitations of various data collection modes, the impact of false negatives or false positives on individual assessment items, and the mapping of assessment items to curriculum elements. Engagement from research organisations is warmly welcomed should they wish to further discuss the data and its potential uses for improving education systems both in Australia and globally.

If you hear someone say they're "not a maths person", tell them there's no such thing! Every child, every student, every person, no matter their age or circumstance, has the capacity to learn. We invite you to join us in celebrating the beauty, function, relevance, and joy that is mathematics.



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