Harnessing Data for Education Transformation:

Catholic Schools Parramatta Diocese (CSPD):
A Case Study

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Google for Education

CSE CENTRE FOR STRATEGIC EDUCATION

Leading educational thinking and practice

Contents

This paper is a collaboration between CSE and Google for Education for the Asia Pacific Leadership Symposia. The Symposia bring together education system leaders from across Asia Pacific to share powerful leadership practices that have high impact in education transformation. The Leadership Papers combine insight into new capabilities for system leadership, analyse innovative strategy, and demonstrate the power of digital to transform learning. They provoke, share and support new thinking and innovation in education.

CSE CENTRE FOR STRATEGIC EDUCATION

Leading educational thinking and practice

The series is intended to encourage discussion of major issues in education. Views expressed by the authors do not necessarily represent views of Centre for Strategic Education. Comments on papers are most welcome.

Background

For too long schools have been shackled under the weight of externally imposed accountability requirements and testing regimes that equate performance (student or school) with success. To their credit, schools have become masters of efficiency, often at the expense of sustainable progress. In a post-pandemic world, schools are under increasing pressure to go beyond efficiency – and making simple changes – to radically transforming themselves, to reflect the realities of their local and technological contexts.

It is not enough to use technologies to do more of the same, more efficiently. This approach misses the mark completely and reflects an industrial mindset, where information and data are contained in siloed, static settings where the 'expert' controls what is learnt, when it is learnt and how it is learnt. While this approach may have ensured uniformity, it has failed to unlock innovation by practitioners.

This narrative is being challenged, as more systems move away from centralised control and planning towards acknowledging that schools themselves are best placed to respond to the diverse needs of learners (Burns, 2022). This system has also begun to realise that centralised control has not delivered the expected outcomes for all students. Rather, the focus now has turned to self-realising, self-evaluating schools that can tell their own stories of progress, using local data for context and system data for comparative purposes.

School Progress Framework (SPF)

In mid 2021, Raju Varanasi and Gina Pianta were asked by the then executive director to undertake research on school self-evaluation frameworks. School self-evaluation allows schools to evaluate their own educational and organisational practices through a process of continual reflection, improvement and development. Further, school self-evaluation embraces the ideals of inclusion, social justice, equity and empowerment, along with processes of participation, dialogue, deliberation and cultural responsiveness (Greene, 2006).

Table 1. Mindset shifts in practice

From	To
system push	school-owned
performance	progress
top-down	bottom-up and middle out
inspection	introspection
imposed	invited
system rating	self-evaluation
comparative rankings	capability and maturity
built-on	built-in
part of school	whole of school
quantitative data	appropriate mix of qualitative and quantitative data
external experts	all stakeholders
external validation	internal reflection
dictating	dialogue
mandatory	opt-in
single-wave rollout	phased implementation
intervention siloes	integrated programs

While the concept of school self-evaluation is not new, there have been different approaches in the design, implementation and reporting, based on the national and international approaches we reviewed. School self-evaluation is something that schools do themselves, by themselves and for themselves, in their efforts to achieve excellence and equity within their own learning community (MacBeath, 2010). It is through this process of becoming more self-aware, self-reflective and self-critical that leaders and teachers build individual and shared capacity to select and evaluate data effectively, generate insights and make decisions that improve student, teacher and community outcomes.

It is important to note that school self-evaluation is not intended as a prescriptive tool or rubric, rather it is a scaffold for school communities to reflect critically on their own processes, practices and pedagogies, and to evaluate these effectively in a coherent and honest way. It is not the endpoint in mind but the journey, which is wholly owned by schools themselves, supported by the system (see Table 1, summarising some of the mindshifts required).

Following a review of the literature, we came to the realisation that in developing our own school self-evaluation framework, it had to fulfil the following.

1. Build capacity of school leaders and staff to self-evaluate their school effectively (school as the entity; school is the unit of analysis).
2. Enable schools to tell their own stories of progress using local, system and external data sets.
3. Reduce reliance on external inspection and validation as the drivers of educational change.

4. Co-construct with schools in the system to build shared vision, a common language and greater trust.

5. Incorporate the voices of the wider school community over time (eg, students, parents, non-teaching staff).

6. Establish conduits and connectors between schools and the system (eg, critical friends to accompany schools on the journey).

7. Encourage dynamic and flexible responses from the system to needs identified by each school.

8. Be life-giving; that is, schools see the process as a meaningful and fruitful activity (MacBeath, 2010).

Key elements of SPF: Domains, maturity states and dialogue prompts

The co-construction process with participating schools embraced these concepts in its development. To encapsulate them, three interconnected 'domains' were proposed. These domains encompass the following core activities of our schools.

- Flourishing (Catholic Identity, Mission, Wellbeing and Partnerships)

- Learning (student and teacher), and

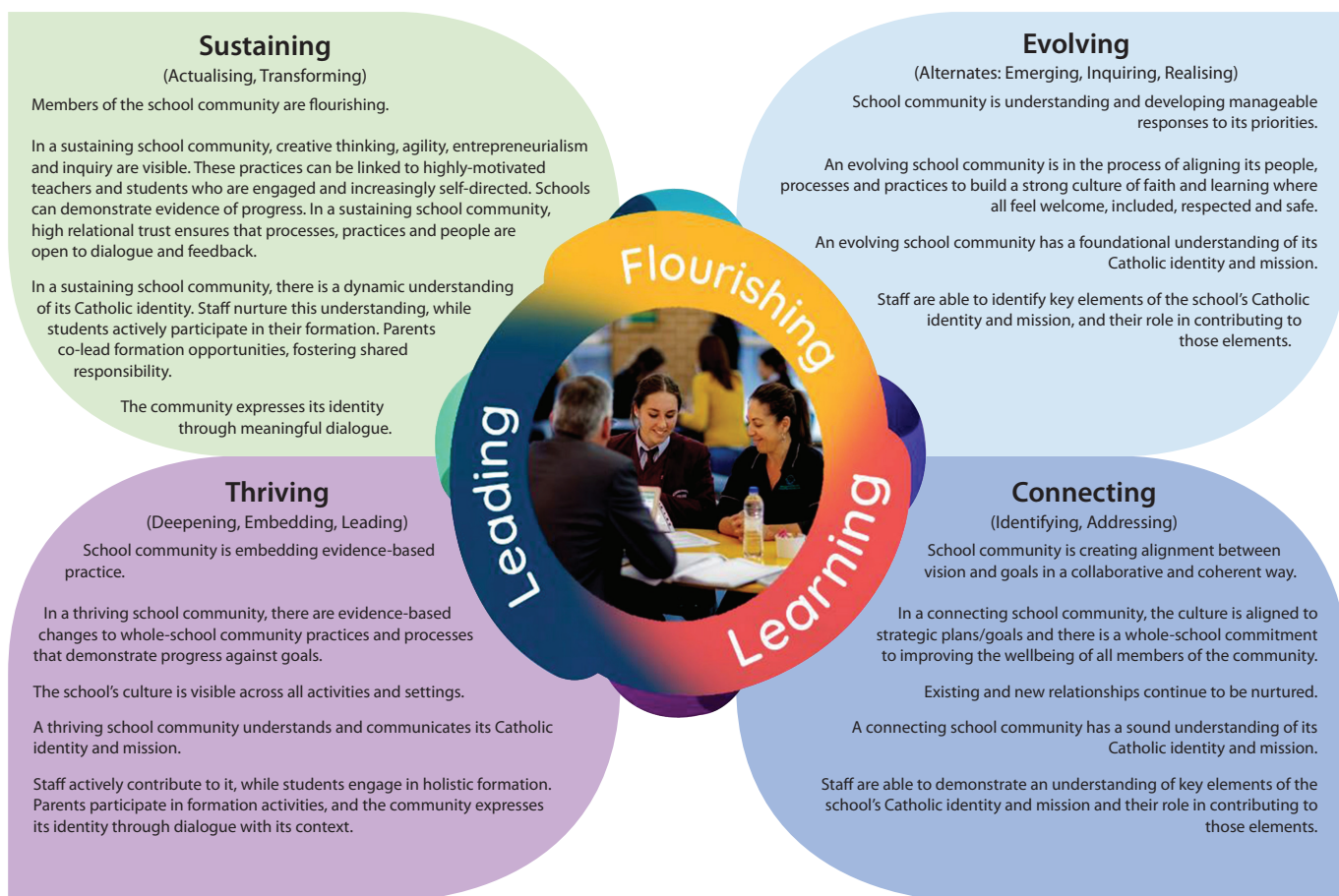- Leading (culture, stewardship of resources, intelligent data-use, professional learning).

To gauge progress of a school's journey, 'maturity model thinking' was introduced. Maturity models are quite prevalent in many sectors of industry but do not seem to have been applied in school education. Four maturity states were proposed to calibrate holistically a school's progress milestones along its journey. To avoid linear thinking and tick box approaches, schools suggested a dialogical model – which reinforces a Catholic worldview.

Maturity, in this context, is the capacity to provide high-quality services (Maier et al, 2012) with an emphasis on **consistency** and **quality**. Consistency of processes and capabilities of staff, reflecting on what is working well and what is not, determines whether the school is able to meet self-identified goals and progress in maturity. School maturity, therefore, is a combination of behaviours, attitudes and competencies of all school participants in carrying out the educational, administrative and related processes within a school community. The domains and the four maturity states are shown in Figure 1 (see page 5).

Schools currently using the SPF are scaffolded to self-evaluate themselves using a *Domain Prompt Guide* – based on Bourdieu's Field Theory (Levi Martin, 2003) – to assess their maturity within each domain, using local and system data sets as evidence. If required, schools can develop their own descriptions within each maturity state. While the domains, maturity state descriptions and sub-categories provide a common reference point across schools, the choice of goals, targets within each goal, and evidence collected (quantitative and qualitative) to demonstrate progress, are determined by school leadership with contributions from its school community.

It is important to note that SPF has never been promoted as a panacea for the challenges facing our schools in today's world. Yet, feedback from schools currently using SPF has reported that the process has been professionally affirming, enhances Catholic mission, provides rigour around reflective practice, deepens teacher dialogue and develops capacity to engage in trusting and collaborative partnerships within the school and central office.

Figure 1. SPF maturity model

Sustaining
(Actualising, Transforming)

Members of the school community are flourishing.

In a sustaining school community, creative thinking, agility, entrepreneurialism and inquiry are visible. These practices can be linked to highly-motivated teachers and students who are engaged and increasingly self-directed. Schools can demonstrate evidence of progress. In a sustaining school community, high relational trust ensures that processes, practices and people are open to dialogue and feedback.

In a sustaining school community, there is a dynamic understanding of its Catholic identity. Staff nurture this understanding, while students actively participate in their formation. Parents co-lead formation opportunities, fostering shared responsibility.

The community expresses its identity through meaningful dialogue.

Evolving
(Alternates: Emerging, Inquiring, Realising)

School community is understanding and developing manageable responses to its priorities.

An evolving school community is in the process of aligning its people, processes and practices to build a strong culture of faith and learning where all feel welcome, included, respected and safe.

An evolving school community has a foundational understanding of its Catholic identity and mission.

Staff are able to identify key elements of the school's Catholic identity and mission, and their role in contributing to those elements.

Thriving
(Deepening, Embedding, Leading)

School community is embedding evidence-based practice.

In a thriving school community, there are evidence-based changes to whole-school community practices and processes that demonstrate progress against goals.

The school's culture is visible across all activities and settings.

A thriving school community understands and communicates its Catholic identity and mission.

Staff actively contribute to it, while students engage in holistic formation. Parents participate in formation activities, and the community expresses its identity through dialogue with its context.

Connecting
(Identifying, Addressing)

School community is creating alignment between vision and goals in a collaborative and coherent way.

In a connecting school community, the culture is aligned to strategic plans/goals and there is a whole-school commitment to improving the wellbeing of all members of the community.

Existing and new relationships continue to be nurtured.

A connecting school community has a sound understanding of its Catholic identity and mission.

Staff are able to demonstrate an understanding of key elements of the school's Catholic identity and mission and their role in contributing to those elements.

School Story: Compact data dashboards

To simplify access to system-level data such as standardised test results, student engagement surveys, student enrolments and exits as part of the reflective process, a *School Story* dashboard was developed (see Figure 2).

School Story has been designed as a 'one-stop-shop' that provides a high-level overview, as a starting point for schools to start questioning and evaluating progress in a systematic way. We are currently working with our SPF schools on the collection of local data sets linked to goals, through established system platforms such as Tableau, Google and Qualtrics, in order to allow schools to share their own stories of progress.

School Story was further enhanced as *School Profile* – an interactive compendium of more than 50 dashboards that give a longitudinal view of a school in terms of demographics, academic achievement, religious composition, participation by indigenous and diversity groups, capital and recurrent expenditures and so on.

Together, the school stories and school profiles generated significant interest in leadership teams to reflect on their achievements, challenges, possibilities and opportunities. For example, two schools in the same suburb noted vastly different trends in enrolments, retention rates, student achievement and parental engagement generating hypotheses of what might be contributing factors. The SPF domain discussion prompts then led to school processes, school culture, teaching and learning, staff collaboration and so on, covering all three SPF domains. Based on their dialogue, collective reasoning and responses, the current maturity state was arrived at and desired maturity guided their goals and targets.
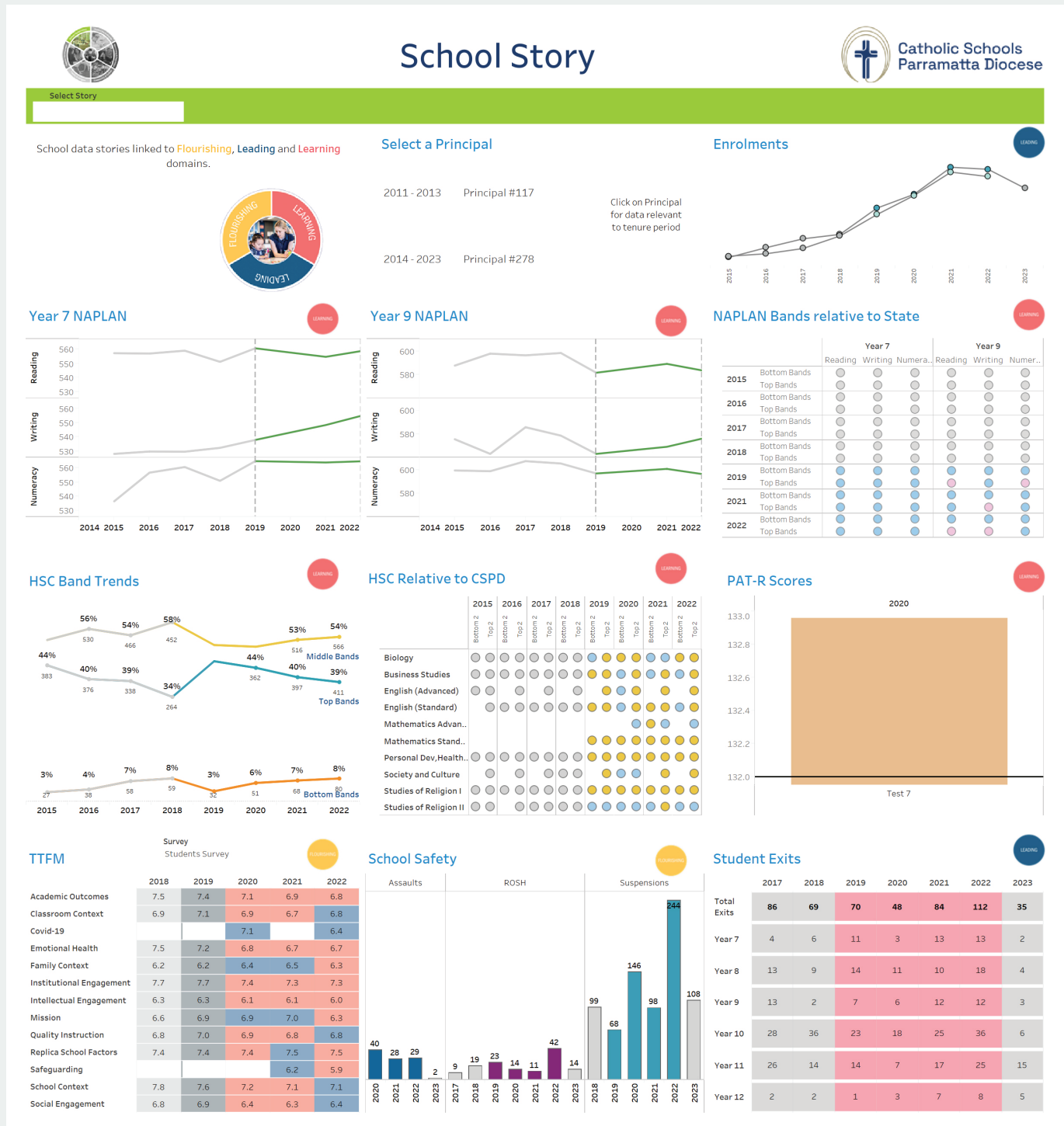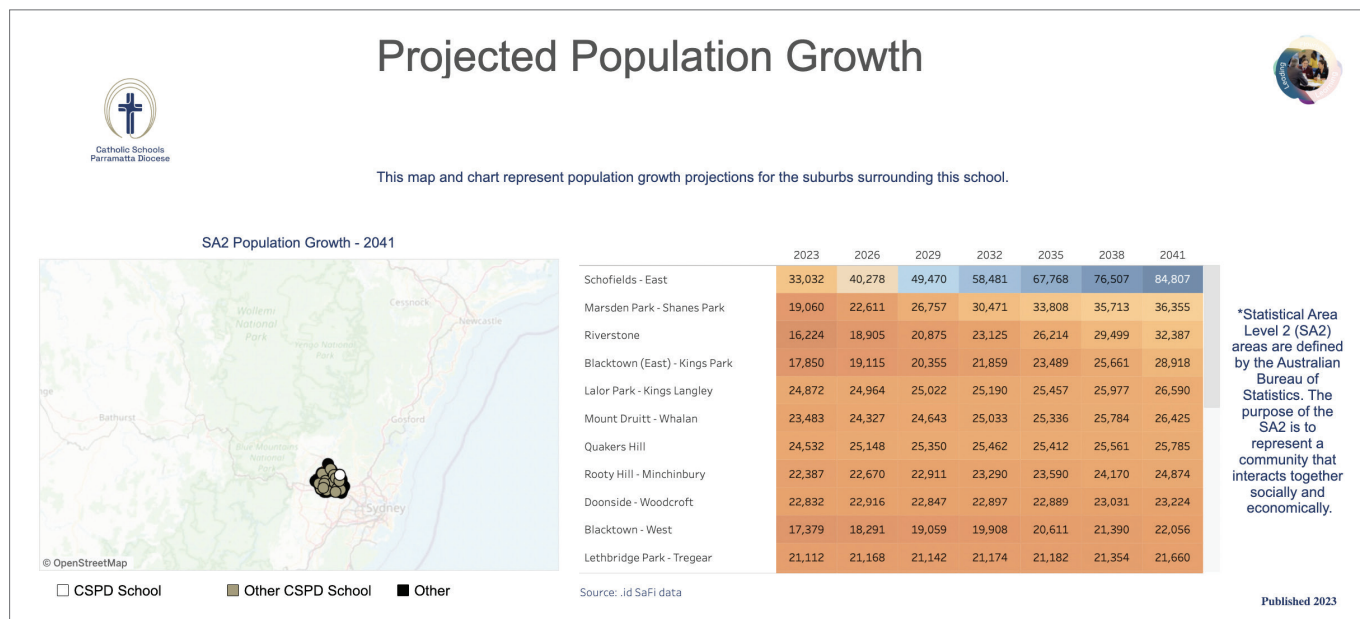
Figure 2. School Story

School Story

Catholic Schools Parramatta Diocese

Select Story

School data stories linked to Flourishing, Leading and Learning domains.

Select a Principal

2011 - 2013   Principal #117

2014 - 2023   Principal #278

Click on Principal for data relevant to tenure period

Enrolments

Year 7 NAPLAN

Year 9 NAPLAN

NAPLAN Bands relative to State

HSC Band Trends

56% 54% 58% 53% 54% (Middle Bands)
530 466 452 516 566
44% 40% 39% 34% 44% 40% 39% (Top Bands)
383 376 338 264 362 397 411
3% 4% 7% 8% 3% 6% 7% 8% (Bottom Bands)
27 38 58 59 32 51 68 80

2015 2016 2017 2018 2019 2020 2021 2022

HSC Relative to CSPD

	2015	2016	2017	2018	2019	2020	2021	2022
Biology								
Business Studies								
English (Advanced)								
English (Standard)								
Mathematics Advan..								
Mathematics Stand..								
Personal Dev,Health..								
Society and Culture								
Studies of Religion I								
Studies of Religion II								

PAT-R Scores

2020

Test 7

TTFM

Survey — Students Survey

	2018	2019	2020	2021	2022
Academic Outcomes	7.5	7.4	7.1	6.9	6.8
Classroom Context	6.9	7.1	6.9	6.7	6.8
Covid-19			7.1		6.4
Emotional Health	7.5	7.2	6.8	6.7	6.7
Family Context	6.2	6.2	6.4	6.5	6.3
Institutional Engagement	7.7	7.7	7.4	7.3	7.3
Intellectual Engagement	6.3	6.3	6.1	6.1	6.0
Mission	6.6	6.9	6.9	7.0	6.3
Quality Instruction	6.8	7.0	6.9	6.8	6.8
Replica School Factors	7.4	7.4	7.4	7.5	7.5
Safeguarding			6.2		5.9
School Context	7.8	7.6	7.2	7.1	7.1
Social Engagement	6.8	6.9	6.4	6.3	6.4

School Safety

Assaults: 40 (2020), 28 (2021), 29 (2022), 2 (2023)

ROSH: 9 (2017), 19 (2018), 23 (2019), 14 (2020), 11 (2021), 42 (2022), 14 (2023)

Suspensions: 99 (2018), 68 (2019), 146 (2020), 98 (2021), 244 (2022), 108 (2023)

Student Exits

	2017	2018	2019	2020	2021	2022	2023
Total Exits	86	69	70	48	84	112	35
Year 7	4	6	11	3	13	13	2
Year 8	13	9	14	11	10	18	4
Year 9	13	2	7	6	12	12	3
Year 10	28	36	23	18	25	36	6
Year 11	26	14	14	7	17	25	15
Year 12	2	2	1	3	7	8	5

Figure 3. Extract from a School Profile

Projected Population Growth

This map and chart represent population growth projections for the suburbs surrounding this school.

SA2 Population Growth - 2041

	2023	2026	2029	2032	2035	2038	2041
Schofields - East	33,032	40,278	49,470	58,481	67,768	76,507	84,807
Marsden Park - Shanes Park	19,060	22,611	26,757	30,471	33,808	35,713	36,355
Riverstone	16,224	18,905	20,875	23,125	26,214	29,499	32,387
Blacktown (East) - Kings Park	17,850	19,115	20,355	21,859	23,489	25,661	28,918
Lalor Park - Kings Langley	24,872	24,964	25,022	25,190	25,457	25,977	26,590
Mount Druitt - Whalan	23,483	24,327	24,643	25,033	25,336	25,784	26,425
Quakers Hill	24,532	25,148	25,350	25,462	25,412	25,561	25,785
Rooty Hill - Minchinbury	22,387	22,670	22,911	23,290	23,590	24,170	24,874
Doonside - Woodcroft	22,832	22,916	22,847	22,897	22,889	23,031	23,224
Blacktown - West	17,379	18,291	19,059	19,908	20,611	21,390	22,056
Lethbridge Park - Tregear	21,112	21,168	21,142	21,174	21,182	21,354	21,660

*Statistical Area Level 2 (SA2) areas are defined by the Australian Bureau of Statistics. The purpose of the SA2 is to represent a community that interacts together socially and economically.

© OpenStreetMap

☐ CSPD School   ▨ Other CSPD School   ■ Other

Source: .id SaFi data

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Catholic Schools Parramatta Diocese

Data storytelling

Historically, school systems only had a few student data points to capture. Regulatory needs were perfunctory and obligations on schools less burdensome. However, school systems today have been deluged with data. It is now a problem of what data matters most. Arguably, over 5,000 different types of data points are captured daily. This includes information on student and teacher attendance, student medical and counselling records, human resource details of teaching and non-teaching, occupational health, workplace injuries, student assaults, professional learning of teachers and other staff, school fee records including debts, payments to school suppliers, network connections and bandwidth usage, device usage, learning interactions (downloads, posts, assignment submissions), student assessment reports, grades and marks, and results in external tests and examinations. The list continues to grow.

While the Six Lens Framework (see Appendix A) represents the first step in the system's data journey to simplify and classify dashboards for users, the second has been the introduction of data storytelling.

Five years ago, Gartner (see gartner.com/en/webinar/445692/1051355) identified storytelling as an important, and perhaps overlooked skill in organisations, in moving people from decision making based on gut feel to decision making based on data insights. While data storytelling is gaining momentum and is seen to be increasingly important in organisations, it is fair to say it is still in its infancy in the K–12 sector, as schools and systems continue to grapple with the data deluge.

Cross-lens approaches are more effective when deciphering an educational challenge, because using multiple measures is considered a better and more ethical practice than a single or summarised one (Goldstein and Spiegelhalter, 1996).

Insights are not always obtained from the 'primary' lens that first identifies the problem. For example, by making conjoint interpretations and cross-referencing early insights and interpretations with later measures using the other lenses, deeper insights, possible hypotheses and solution alternatives can be sought. The data stories elaborated use this approach.

Data storytelling builds on the Six Lens Framework and shares the vision of making data a key lever for all significant interactions and decisions across the system. In short, we see it as building bridges between the data (eg, visualisations), users and actionable insights, through stories that impart, ignite and inspire people to think and do differently to improve student outcomes.

Several shifts in mindset have occurred, with rises in volume, velocity and variety of data. Data was stored and kept safe, but seldom leveraged for visualisations and dashboards. The shift to make data flow and distributed has opened opportunities to share insights more easily to internal and external stakeholders. Similarly, ability to aggregate and filter data by categories has assisted in dissecting data sets – to drill down based on using several hypotheses to accept or reject with true transparency. The tools, techniques and IT systems used had to be altered significantly to meet the new mindset. These shifts are summarised in Table 2.

We depict four data stories here as an example. These stories are cast through the concept of 'journey' – of students, cohorts, teachers, schools or the system. The democratisation of this data across schools, and the humanisation through insights and stories, is helping accelerate action.

Data Story 1 covers student exits in the school system and at school level. Exits by scholastic year and reasons provided by parents and principals give further insight on the trends, as shown in Table 1. Student exits are an expected part of the school journey – families move suburbs, students move schools for better opportunities or to take up alternative pathways such as employment or a trade (see Data Story 1 – Exits).

> Data storytelling builds on the Six Lens Framework and shares the vision of making data a key lever for all significant interactions and decisions across the system.

Table 2. Mindset shifts induced by growth in data

Mindset	From	To
Function	Store	Flow and distribute
Stakeholders	Leadership	All staff, parents
Unit of analysis	Aggregate, homogeneity	Granular, heterogeneity
Event	Past	Current
Mode	Static	Dynamic, real time
Form	Reports	Visualisations, dashboards
Focus	What happened?	What's happening? What might happen?

Data Story 1: Exits

Historically, reasons for leaving were documented at the school with no 'system view' of the number of exits per school, per grade, per year or the reasons why parents were leaving and the overall cost to the system.

The creation of a real-time student exit dashboard and automated student exit survey sent to families shortly after leaving a system school has enabled system leaders to gain a better understanding of the challenges around student retention.

Insights have helped the system re-prioritise investments beyond boosting enrolments to how schools can be supported to retain, where possible, students within the system.

Scholastic Year Exits

Exits in Years 1 and 4 in Primary, Years 8 and 9 usually signal dissatisfaction and disengagement.

Family Experience

- Positive
- Negative

Destination School Sector

- Catholic
- Gov't
- Ind.

Parent Reasons

Reason	Value
Other	32
Dissatisfied with the school	21
Moving residence	17
TAFE/Apprenticeship/Trainees..	8
Employment	3
School fees	2
Recommended by the school	1

Principal Reasons

Reason	Value
Moving residence	155
Other	150
TAFE/Apprenticeship/Trainees..	54
Difficulty with peers	46
Employment	30
Recommended by the school	11
School fees	11
Subject choice/offerings	6

Parental experience should hold primacy. Note that parent reasons differ from what the school principal comes to know of the student exit.

The grey line (previous year) and the pink line (current year) have similar trend. The story repeats each year!

Current vs. Historical Exits (Running Total)
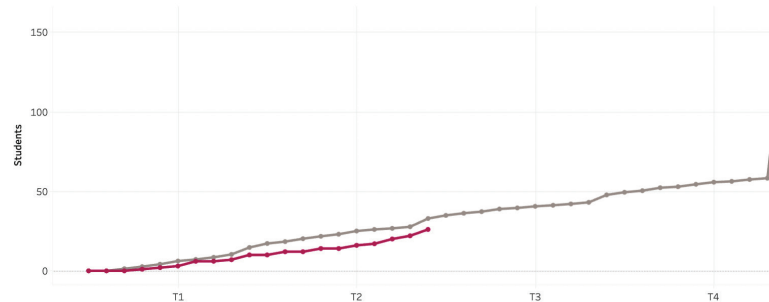
Data Story 2 is about the attrition of beginning teachers. The experience of our exiting students leads to us asking about teacher quality and the experience of exiting teachers. The current teacher shortage issues have further diluted the expectations around teacher quality. Consequently, the challenges in addressing early career teacher preparation, mentoring support, professional learning and certification against teacher standards have taken a back seat.

The system had over five years of data of teachers joining the system and their progress over time. Using the teacher ID, we have tracked their professional accreditation journey in both primary and secondary schools. We were shocked to see that the system has lost most of the early career teachers in three to five years. The causal factors were hard to determine without surveying the exiting teachers.

Data Story 2: Beginning teachers

The visualisation points out that we tend to take most of the intake from just two universities. One may question why the limitations are put in the first place and whether there is a quality effect as a consequence. Also, most of the intake is casual to commence with.

Teachers by University and Type
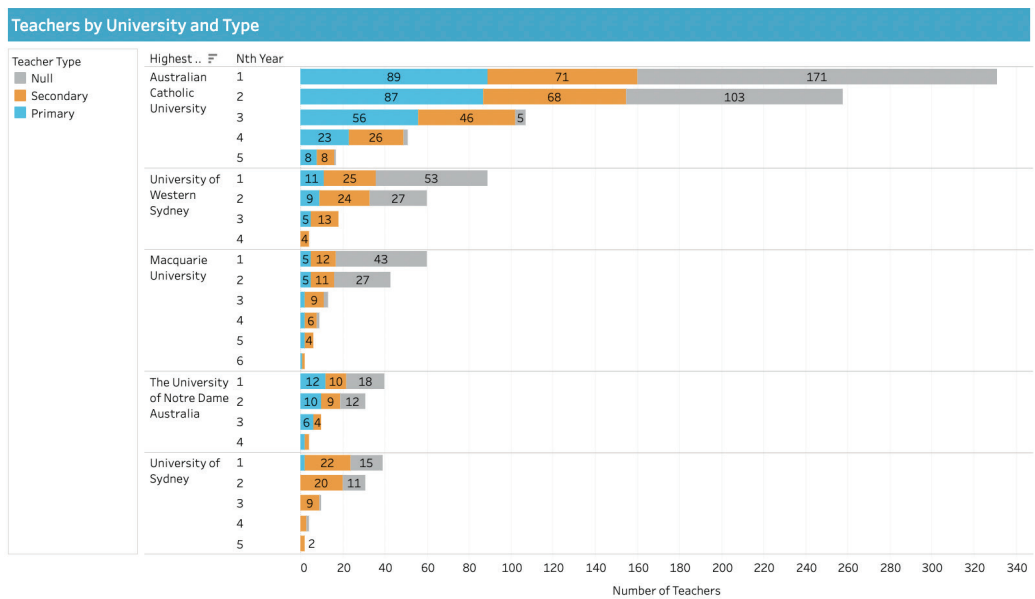
The journey of beginning teachers (early career teachers in most cases) reveals the extent of attrition in the first five years. Reasons remain unknown without surveying the exiting teachers.

Research states that beginning teachers usually leave due to lack of mentoring support, high administration workloads, challenging classroom student behaviours and casual employment. When visualised, the story starkly demonstrated the need to monitor early career teacher journeys. The system has initiated surveys to better understand root causes.

Teacher Development and Attrition
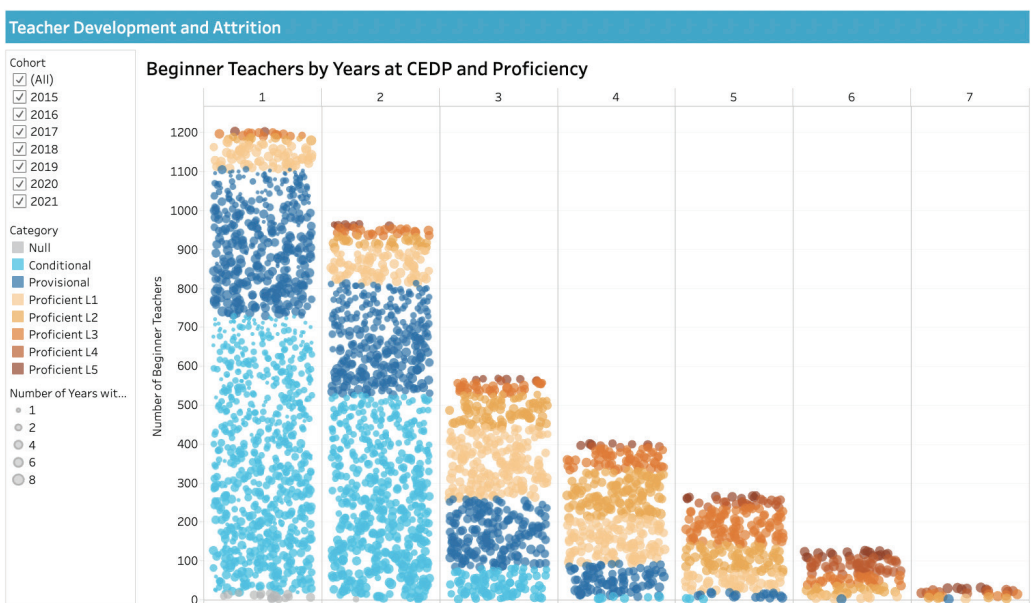
Data Story 3: Student journeys

Student learning journeys through the NAPLAN to HSC lens can be tracked from Year 3 (2011) to HSC (2020).

Strong association between NAPLAN scores (Numeracy and Reading) in Year 3 and HSC performance – although nine long years apart. Good and not so good news here.

One way to interpret this insight is that the fate of HSC performance is all-but determined in Year 3.
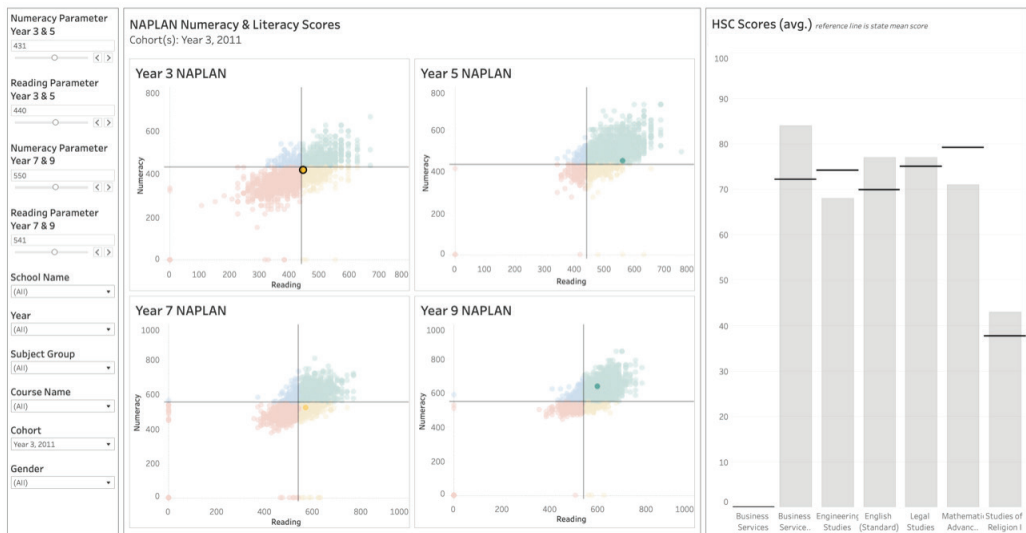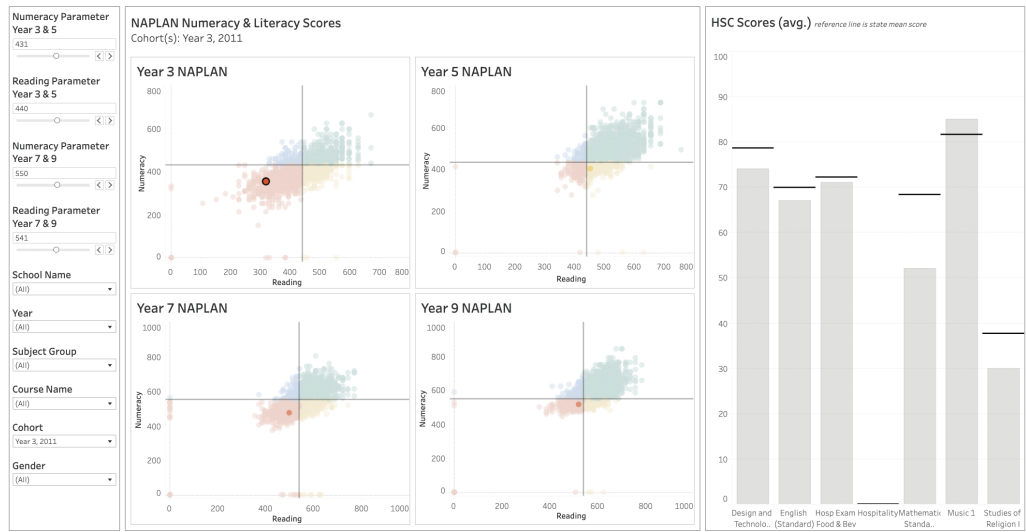
Since K–2 has no standardised testing data, we have only been able to chart the journey from Year 3 onwards.

Reliable K–2 data would enable teachers to intervene early enough to close the gap.

Students in the 200–300 range are the system's most academically vulnerable; despite a decade of targeted interventions and support there has been little growth in NAPLAN or HSC.
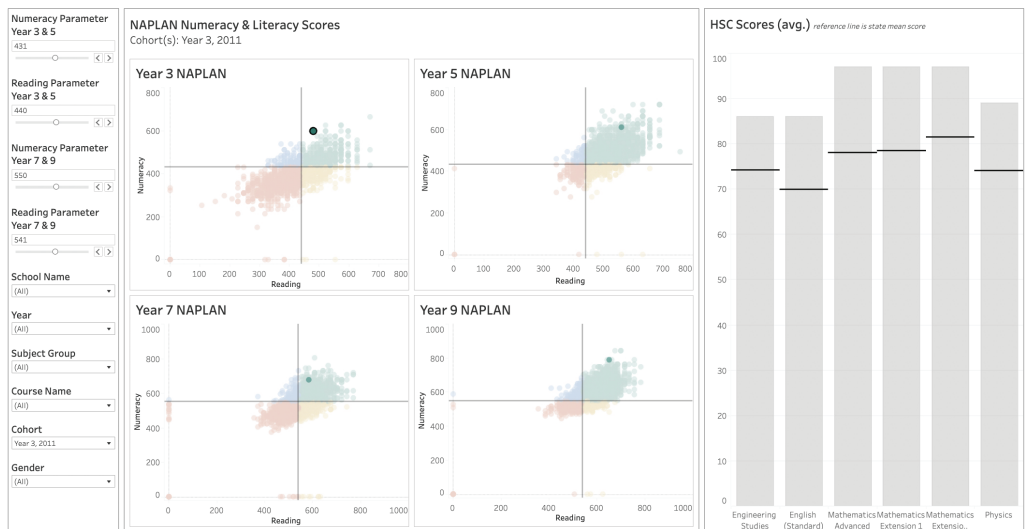
The system had invested significant time and money in professional learning effort for the early career teachers. Either the professional learning had little impact, or the teachers were sought after by other school systems due to pay and other conditions – we are not sure. Several such hypotheses can be proposed but cannot be ascertained until we collect experiential data through surveys.

Data Story 3 is on the insights gained from student journeys.

A student's 13 years of schooling can be shown as a journey. We argue that it is time this valuable journey in the student's most formative years is visualised as an end-to-end experience of schooling. In our system, this is referred to as a pre- to post-schooling experience that should be seamless for students and provide teachers with rich insights from those student data journeys.

> We use 'journey' as a metaphor, to expose hidden opportunities for school systems to improve any aspect of schooling with granular, contextual data captured over time with visual and predictive analytics.

If data is seen as a longitudinal set of static student PDF reports, they do not necessarily highlight the rich experiences of a student's learning journey – and, more broadly, the schooling journey in a holistic and interactive way for future career, work and life purposes. Also, these reports often pit students against each other for rankings in achievement, rather than reflecting their personal learning journey and promoting the collaborative mindset that the future demands of our learners.

We use 'journey' as a metaphor, to expose hidden opportunities for school systems to improve any aspect of schooling with granular, contextual data captured over time with visual and predictive analytics. Metaphors are useful in conceptualising and studying phenomena and can provide new perspectives, and new forms of conceptual insight and knowledge (Zhao, 2012).

Examples of student journeys examining analytically and visually the students' progress – using standardised tests such as NAPLAN for scholastic years 3, 5, 7 and 9 – can be depicted as shown in Data Story 3 (on page 11).

Predictive analytics (HSC)

(For illustration, see Data Story 4.)

Having hinted that the missing piece in supporting student learning is indeed the K–2 student journey, we have embarked on developing a predictive model, so that learning interventions are provided well before a student sits NAPLAN Year 3 tests.

Four years ago, we wondered if we could predict HSC outcomes reliably from the available data in order to ensure due support is given to students well before the HSC exams. Having demonstrated the power of data through stories to generate insights and thus signalling transformational opportunities, we now elaborate on our successful experience with machine learning and predictive analytics. Predictive analytics, conducted using past data to predict the future, is a category of data analytics aimed at making predictions about future outcomes based on historical data and analytics techniques, such as statistical modelling and machine learning. Predictive analytics covers the practice of identifying patterns within data to predict future outcomes and trends.

As mentioned earlier, the majority of available data is internally generated through transactions, interactions and profile analysis. Vast amounts of data on attendance, fees, grades, behaviour reports, allergies, prizes and awards, and far more, is stored in individual schools and/or in enterprise systems daily.

Typically, students are known by their respective profiles and performances during their 13-year enrolment relationship with schooling (Kindergarten to Year 12). In this data story, we use student background, demographic information and learner achievement, and outcomes were used to predict Higher School Certificate (HSC) marks.

This story exemplifies the need to move from retrospective to the prospective, reactive to proactive, and investigated correlations that exist between input variables and student outcomes. Some prominent input variables are attendance rate, country of birth, NAPLAN reading and numeracy scores, days in Australia, PAT-R Stanine (Progressive Assessments test scores), language background, disability status and type, school, and student residential suburb's socio-economic rating. The Target Variable: HSC Score.

Courses selected for modelling High School Certificate marks as predictions include Ancient History, Biology, Business Studies, Chemistry, English Advanced, English Standard, General Mathematics, Geography, Mathematics, Modern History, Health PE, Physics, Studies of Religion I and Studies of Religion II. These courses

have higher candidature in the school system compared with the 80 other subjects offered in the HSC. The algorithms account for course difficulty, between-course differences, hierarchically nested courses (eg, levels of mathematics), and between-school differences by 'learning' from past data – a process in which different samples of the data (cross-validation data sets) are extracted to evaluate the relative importance of the variables.

Automated machine learning models were used and deployed with past data. Over 40,000 records of 8000 students, spanning ten years, were used to train the model. Model deployment is where the data model can then be 'run', and the target variable is scored. The data set is split into three subsets – *training* data from which the machine learns, the *validation* data by which it scores and learns further to fine tune the model, and finally, the *holdout* data set which is used to verify that the final model performs well on data that has not been touched throughout the training process and is the data to be predicted for the latest cohort yet to sit for the high school exam. The performance metric used for this project was root mean square error (RMSE).

Data Story 4: Predictive analytics

### Actuals with Model Accuracy
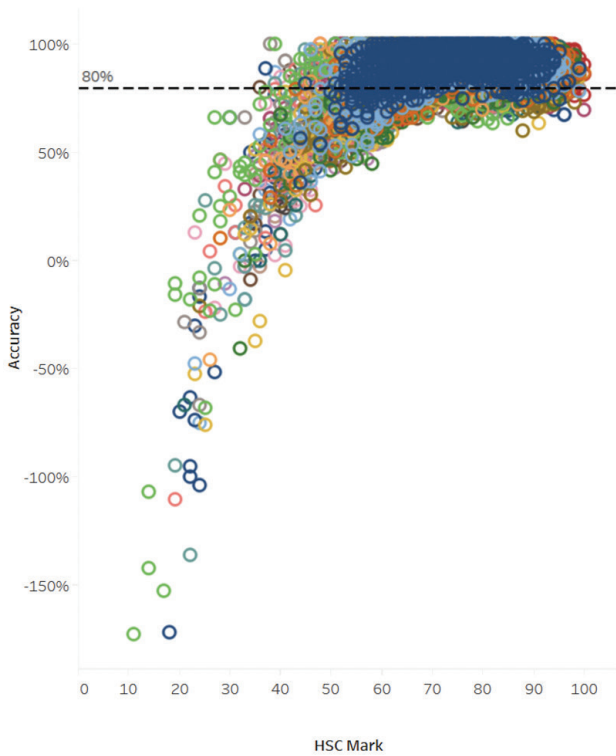
Model Accuracy as Bins
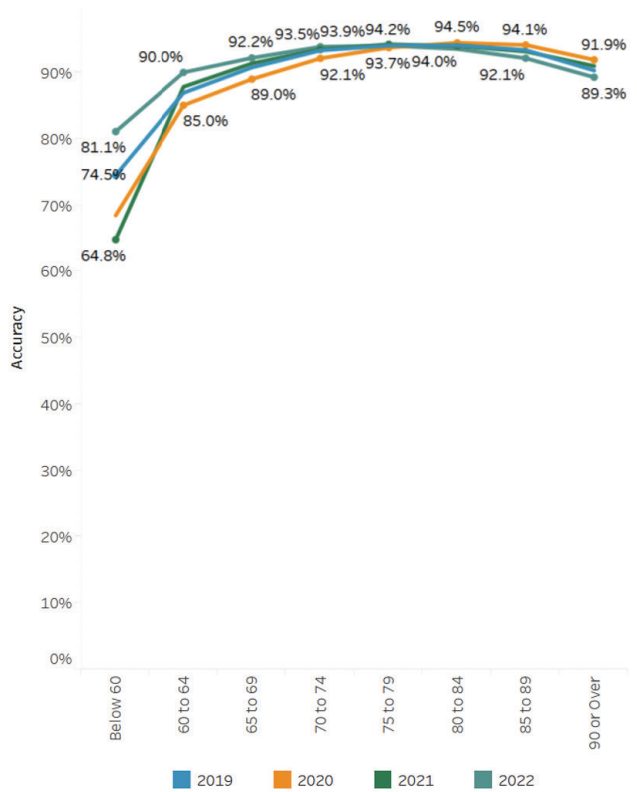
The model predicted with over 90 per cent accuracy in all the four years. Put differently, the story illustrates the point that targeted, meaningful support for students can lift their achievement levels.

The students in the system showed stronger achievement in Advanced English as evidenced by the close clusters at the higher axes points.

The story is different for Biology – more dispersion, more outliers and lower achievement compared to Advanced English. Subject strengths vary remarkably across schools and across school systems. This provides opportunities for teacher collaboration and professional learning across schools.

Actual vs. Predicted

Actual vs. Predicted
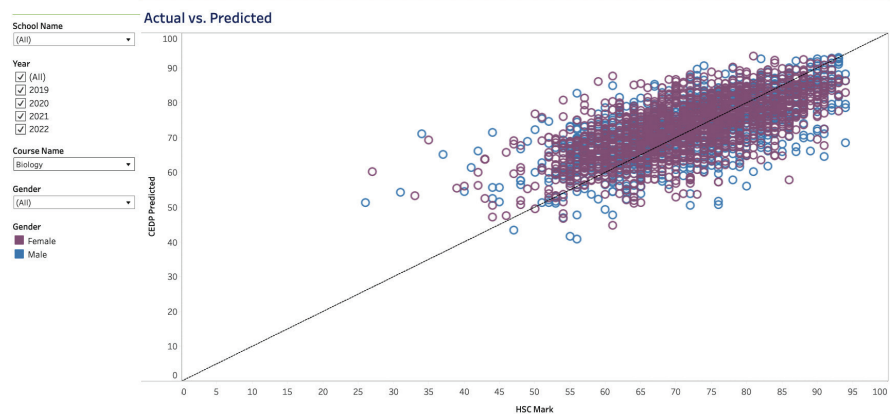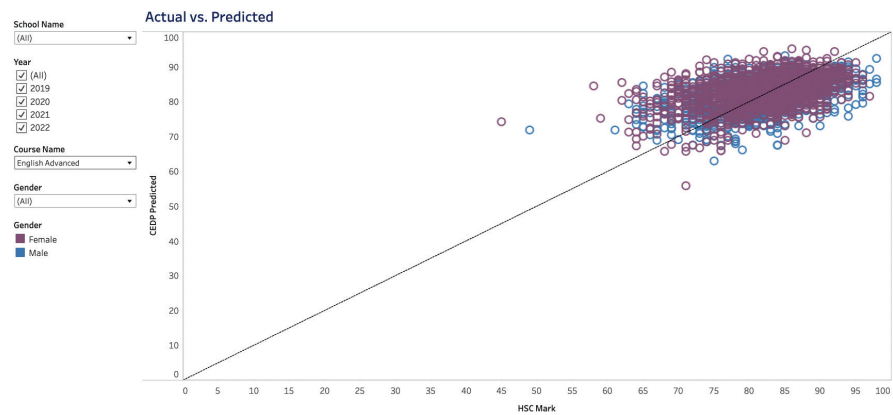
Data fluency

While the need for school leaders and teachers to develop strong data-literacy skills is critical (Lai and Schildkamp, 2013), it is yet to be considered a priority in many schools and systems. Data is often viewed as an add-on rather than integral to the work. We have approached this through dialogue with schools, rather than dictates, and to highlight the potential of visualisations and data stories rather than looking at data punitively, which is often how data has been used with schools. In mid 2021, we identified ten schools with the lowest Tableau usage across the system. This became an opportunity to socialise data visualisations and to highlight the power of good teachers using data insights to improve the quality of teaching.

We offered to spend 90 minutes with the school executive team 'talking data and insights'. Prior to the visit, schools were asked to nominate three areas they were interested in learning more about (eg, specific dashboards, HSC predictives, gallery reports, etc.). We tracked Tableau usage before and then at 30, 60, 90 days and six months after the initial visit, and found that almost all schools had increased the number and type of dashboards viewed (see Figure 4).

Following on from these results in data usage related to school visits, a series of workshops has been planned to build the capacity (top-down and bottom-up) for school leaders and a data champion within the school – to collectively understand, analyse and communicate data effectively. These initiatives are contributing to the maturity of CSPD's data analytics journey and underscore that data-use and data-informed decision making can be a powerful form of school self-evaluation, if quality data is used systematically for evaluating and improving instruction and function (see The 5 Ss of Storytelling).

The 5 Ss of Storytelling

Simplifying, and
Socialising data to tell
Stories that lead to
Strategies to improve
Student outcomes

Figure 4. Dashboard viewing
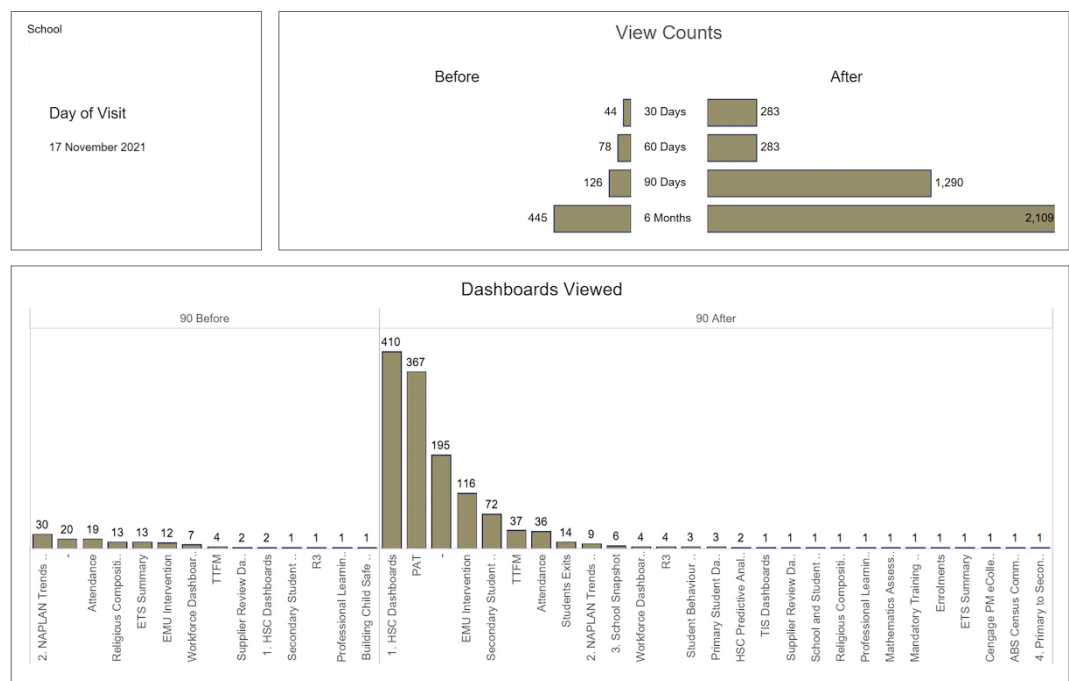
Policy impacts of data in school education

In contemporary school systems, data is innately digital – captured and made available in applications used in almost all activities of schooling. From school and class attendance, student and staff wellbeing, student behaviour, parental engagement, school-based assessments, national tests and other milestone examinations.

Data originates and flows in through a range of source systems. In most schools and school systems the data points thus captured are kept siloed and seldom blended and triangulated to generate a more holistic story of students and schools.

Data provides a 360-degree view of a student's profile. However, student data seldom has a single physical or virtual home in most school systems. It is with the 'expert' – and expertise, by its very nature, is segmented, siloed and kept under wraps. Data has to see the light of the day for it to be useful for its practitioners. At no time in the history of schooling have we had access to so much data that provides insights where the students are, where they have been and where they are predicted to go – the entire student journey.

> the **internally** generated data complements and enhances the **externally** imposed policy conditions.

Governments across the world are currently focusing on their schools and school systems for better student outcomes using a range of policy interventions. These interventions – sort of levers in the context of this paper – include tightening school accountability, updating curriculum, expanding approaches for teacher training, mandating teacher standards, tightening accreditation, advancing standardised testing, introducing outcomes-based school funding and comparing through international benchmarks, to name a few.

A common feature of all these policy levers is that they are **externally** imposed by agencies outside the school system. Many of these policy changes are perfunctory and rarely percolate to the confines of a classroom. They are widely noted by school leaders and other practitioners as unremarkable in achieving sustainable progress.

In contrast, data generated by interactions and transactions in a school and its school system is **internally** generated, originates in classrooms and other learning spaces, is inherently contextual, sufficiently granular, born digital, can be grouped or aggregated and utilised in near real-time mode to obtain the pulse of the school – its students, teachers and parent community. It is intelligence in real time if the right mindsets and scaffolds are in place.

Further, the **internally** generated data complements and enhances the **externally** imposed policy conditions. While externally imposed policy conditions are universal to all schools in a state or country, the internal data is distinctively unique to the school and its system, making it an exceptionally useful lever to inform school progress. The data stories provided earlier on student exits, student journeys, beginning teachers' attrition and predictive analytics exemplify the possibilities of progress well within the realm of schools.

Ten take aways for school leaders

1.	**Data is a lever for school progress**	Longitudinal data – local and system-wide – underscores the importance of school and student journeys.
2.	**Stories humanise data**	Data is not a just a number or series of points. There is a human condition behind data.
3.	**Schools can progress from within**	Progress relies on people and practices. Much of it is from within a school. One-off expert visits or consultant reports are usually peripheral. As Richard Elmore (2009) said, schools must learn the work by doing the work.
4.	**Reflective practice needs data**	Deepened with data, reflection is stronger.
5.	**People data helps capacity building**	Data on people – principals, teachers, staff, students – gives clues for capacity building through ongoing training, mentoring and professional development.
6.	**Equity (or lack of it) is hidden in your data**	Granular, contextual data can unveil inequity when drilled down.
7.	**Predictions can prevent problems**	Switch your mindset from retrospective to prospective. Proactive interventions can prevent problems.
8.	**Data stories can bridge the gap between system and school leadership**	Data is also a connector for shared understandings between system and schools.
9.	**Data culture**	Shared data builds trust and relationships; allows for greater visibility of people's work and eventually less paperwork.
10.	**New forms of accountability**	Integrated analytics can inform school systems and their resourcing agencies, giving more transparency around school progress. This creates opportunities for new forms of governance and accountability.

Conclusion

Data and its downstream services generates value through analytics and insights. We see data as effectively serving **retrospective** and **prospective** approaches to enable transformative efforts in education. This allows schools to engage in a process of self-discovery and to examine fundamental questions often asked by those who are familiar with and have been part of the journey: How did we get here? What makes us unique to our communities? Also, school systems can take prospective approaches by examining external factors – population growth, the number of school-aged children in communities, investments in public infrastructure, competition from other school systems, and so on. Where can we go? What role can we play in the future learning needs of the community?

The data journey of this organisation is by no means finished. As we evolve in our thinking and maturity, each stage over the past seven years has challenged as much as inspired us to continue to question the status quo and prevailing mindsets, to remain curious and be innovative. Our focus remains on harnessing the opportunities of data and today's technologies to empower school communities and enable teachers to transform the lives of the young people in their care.

The education sector, especially school education, is often mentioned as a late adopter of technology. While remote learning – in the wake of COVID-19 – has propelled the interactional and transactional use of technology in learning, the full potential of technology is yet to be harnessed in K–12 school settings, especially in leveraging data and its exciting derivatives – visualisations, dashboards, insights, storytelling, predictive analytics and AI – for their transformative abilities.

The School Progress Framework and data stories from this paper humbly illustrate how we in school education are neither late in adoption nor slow in execution.

> Data and its downstream services generates value through analytics and insights.

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Glossary

Analytics	Systematic analyses of data to discover, interpret, visualise and communicate patterns and trends to derive actionable insights.
Attendance level	Sum of possible school days for students attending more than or equal to 90 per cent (of the time) **divided by** the sum of possible school days for all students **calculated as a percentage** (Australian Curriculum, Assessment and Reporting Authority (ACARA, 2020).
Attendance rate	Actual days (or part-days of) in attendance over the reference period on a possible school day divided by the possible number of days that a student is expected to attend school over the reference period **calculated as a percentage** (ACARA, 2020).
Attribute	A feature or characteristic of someone or something. For example, scholastic year is an attribute of a student.
Band	A range of scaled scores often used in standardised tests and major examinations.
Big data	Large or complex data sets that cannot be processed adequately using traditional data processing methods.
Concept	Concepts are variously described as ideas and abstractions, complex mental formulations, and cognitive and behavioural constructs. Concepts are dynamic and contextual, and may vary over time as new knowledge is developed.

Glossary

Conception	The capacity or process of understanding a concept, and hence is individuated and subjective.
Coupling	The degree to which sub-units (parts) are connected to each other to become a unit (whole).
CSPD	Catholic Schools Parramatta Diocese
Dashboards	A collection of interactive visualisations where users can click to zoom, filter or highlight for more details on a graphic.
Data	Numbers, labels or categories representing qualitative and quantitative measures of students, teachers, schools, courses or programs. While structured, quantitative data is the current focus of analytics, unstructured text data is growing in importance.
Educational system	Institutional settings in which processes of education are embedded. Such institutional settings include schooling systems and vocational training, as well as tertiary and higher education systems.
Emergence	Emergence is the ability of a system to do something its separate parts cannot. Emergence is an elaboration of Aristotle's observation that the whole is more than the sum of its parts.
Governance	The processes of establishing priorities, formulating and implementing policies, and being accountable in complex settings.
Insight	The act of being able to see or understand something more clearly or more deeply.
IT	Information technology. The technology involving the development, maintenance, and use of computer systems, software, and networks for the processing and distribution of data.
ICT	Information and communications technology is an extensional term for information technology (IT) that stresses the role of unified communications and the integration of telecommunications (telephone lines and wireless signals) and computers, as well as the necessary enterprise software, middleware, storage and audio-visual systems that enable users to access, store, transmit and manipulate information.
Learning gain	A calculated measure internal to our school system. The formula involves current score, previous score, typical score (at relevant grade level), and expected gain over a set period (eg, after two years) of schooling.
Meta-analysis	A method for systematically combining pertinent qualitative and quantitative study data from several selected studies.
NAPLAN	National Assessment Program in Literacy and Numeracy (in Australia) – a standardised testing program for school students in Years 3, 5, 7 and 9. It is similar to reading and mathematics tests administered in the US.
PISA	Programme for International Student Assessment – promoted as a 'survey' that tests skills and knowledge of 15-year-olds, held once every three years to evaluate education systems worldwide.

Glossary

Reform	Correcting the past or re-forming the previous condition to an improved state.
School system	A collective of 'like' schools. The likeness of schools could be due to a commonality of funding (as in public schools), governance by church or other faith-based institutions (as in Catholic schools) or autonomy (as in independent schools), or geography (as in school district or districts).
System	A system is an arrangement of parts or elements that together exhibit behaviours or meaning that the individual constituents do not.
Systemness	Having a systems mindset, a way of thinking about change coherently and systematically; a necessary commitment and an understanding that one can give and benefit from the system in transformative ways; a commitment to contributing to, and benefitting from, the larger system. Usually expressed as a set of characteristics that a system in question is expected to exhibit to be considered a system.
Transformation	A new mindset, a paradigm shift in form, composition, processes, and disposition aimed at forging a new and improved form or future condition.
Visualisations	Charts or images that represent a large volume of information, to make it easy to see trends, patterns, relationships, gaps and outliers.
Worldview	Worldview as a cognitive orientation of an individual toward a concept or set of concepts – in our case, the concept of system. A worldview might involve a particular philosophy and a set of themes, values, assumptions and emotions.

Appendix A:
The Six Lens Framework

A Six Lens Educational Analytics Framework was designed for CSPD, for holistic school and system analytics. The six lenses are

- school progress
- student progress
- community and culture
- family and religion
- resourcing and regulatory, and
- teacher development.

The Educational Analytics Framework is shown in Figure 5.

The framework encapsulates a '360-degree' view of all that impacts students in terms of schooling data, while each lens allows for deep analysis of relevant schooling activities, such as student attendance, school-based assessment and teacher professional learning. A cross-lens view often provides the most valuable insights. The metaphorical lens – used as an analogy for the illumination and magnification of different aspects of data –

leads to actionable insights and alternative solutions.

Three of the lenses largely derive their data from internal activities and practices in the school system. They are *school progress, student progress* and *teacher development*. The other three lenses – *resourcing and regulatory, community and culture* and *family and religion* – are largely based on external influences. Together, the six lenses provide opportunities for holistic data analysis, using multiple measures of a given educational challenge. Each lens has one or more dashboards associated with it.

The framework proved to be a very useful tool for school-level and system-level leaders who are responsible for planning, management, and decision making on a range of aspects related to schooling **from** teaching and learning **to** operations and resourcing. The purpose of this framework is to utilise data to maximise opportunities provided by schools for their students to achieve their potential.

Figure 5. The Six Lens Educational Analytics Framework
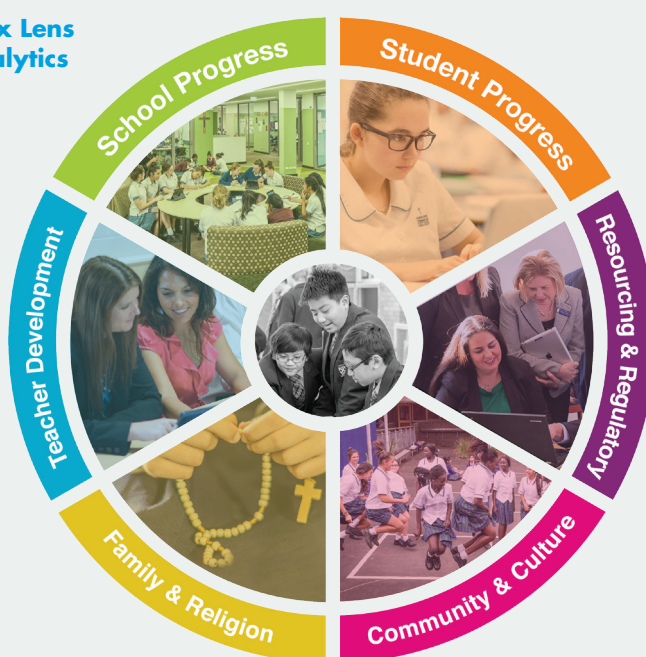
The six lenses are explained below.

School Progress

This relates to school-level analysis. The centricity of analysis is the school rather than the student, teacher or education system. This lens assists in the analysis of school progress over time on any specific educational issue – such as reading, mathematics, external tests or examinations. It can also be used for comparison with other schools or groups of schools, within or outside the school system (eg, to examine different success rates in schools for the same learning intervention or for a similar intake of students). With time series data, the lens proves to be powerful in enabling correlation analysis, causal studies, cohort analysis, peer influences and intervention success. A school dashboard provides school leaders with an at-a-glance view of the school from an analytical perspective.

Student Progress

This compiles, personalises and tracks a student on all relevant aspects of their schooling and personal progress. In fact, a student dashboard is constructed and their profile is visualised from the data accumulated using the student's identifier. Since the dashboard is refreshed daily, when students move from the primary to the secondary years, or change school within the system, the dashboard reflects the change in real time. The student dashboard includes both academic and non-academic progress information. Attendance, extra-curricular activities, behavioural and personal and other medical changes are also displayed in the student dashboard as appropriate. It is foreseeable that, in practical terms, the student dashboard will become a more comprehensive, real-time and interactive digital version of the student report.

Teachers can use the student progress dashboard during their conversations with parents, eliminating the need to gather disparate physical records.

Teacher Development

Includes teacher-centric data such as accreditation against teacher standards, qualifications, experience, system-based professional learning (and school-based, if available), payroll and leave records, and other relevant demographic information. The teacher development dashboard, like the student and school dashboards, profiles the teacher on several attributes, which can be used for comparative reporting, inter-correlation, modelling and causal analysis.

Resourcing and Regulatory

Covers school funding, finances, fee levels, fee collection, debts, enrolment capacity of schools, capacity utilisation over time, building and facilities data, procurement, student attendance (including subcategories of explained and unexplained leave, sick leave, etc). Even extremely sensitive data relating to the aggregate number of bullying incidents or complaints (without divulging names or other specifics) can be used to correlate with other operational and learning attributes. This lens is administrative in nature but can throw new light to complement insights gathered from other lenses on school leadership, stewardship of resources and school culture.

Family and Religion

Covers data on student demographics, family attributes (such as parental education/occupation and number of siblings), and religious affiliation. This lens has significance to research literature, as family attributes are known to be strong predictors of student success.

Figure 6. Six Lens example

Prior to 2020, stagnating enrolments and weakening reputation and lower achievement in NAPLAN and HSC.

New principal, high expectations, greater harmony amongst staff, focus on building teacher and school leader capacity, sometimes using external expertise. Resulted in high growth in enrolments, greater demand for Year 7 places, improved student learning gain in most subjects.

The students who are in the left of the lower quadrant – low in reading and numeracy in Year 3 – have had variable progress depending on the school.

On further probing of the interactive dashboards, it is possible to home in on the under achieving schools to be able to resource and support them contextually. Also, if K–2 data were able in a comparable manner, it would have been easier to tailor more personalised support in the early years, well before Year 3 NAPLAN.

The linkages between professional learning input effort against school or student level outcomes is not evident. It is also revealing to note the amount of mandatory and compliance training hours spent by teachers and other school staff.

As regards school roles, it is surprising to note that principals and assistant principals get almost as much professional learning time as the teachers. Are schools using data to inform who should attend what training depending on capacity building plans?

School situated in a high population growth area has falling enrolments for five years in a row. Students exiting in middle of the year to other schools.

The student religious background shifting fast from Catholic to Hinduism and Islam. As diversity in community changes, parental expectations, student needs and school enrolment strategies need to evolve accordingly.

A primary student Daniel is absent on all Tuesdays in a term. Otherwise, the attendance and other indicators are fine. The school did not realise this pattern.

When approached, the initial hypotheses included possible parental shift work and family commitments leading to absence on Tuesdays. Daniel's mum, when contacted, apologetically stated that she is saving up for buying sport shoes as Daniel refused to go to school and sport without sport shoes.

Contrasting views from parents and teachers in an annual experience survey – Tell Them From Me. While parents felt less welcomed, less informed, that school was not supporting diverse student needs, and their participation was not sought. However, teachers rated themselves as collaborative, strong learning culture, positive learning environment and good parental engagement.

The contrast is starkly different. This leads to the question whether the school is pulsing their school communities clearly.

Community and Culture

Covers socio-economic data on the community. It includes population and population growth rates, enrolment analysis to compare growth and decline for schools in the community, and proximity analysis of schools in the community, to better understand competition between schools within the system and from the outside. This lens can draw upon indices developed for socio-economic areas and zones, early childhood development and a raft of other measures made available from recognised health and community service groups. This lens can also extract data from periodic surveys undertaken by the school system to obtain information on community engagement, school culture and school climate.

The Appendix material is sourced from the following.

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Appendix B: Data management

Data management is a foundational element of analytics and machine learning. Data from source systems such as a student management system, human resources or financial system is not always in a consistent format. For example, student identifiers can be stored as strings or numbers, dates can be expressed in several different formats, and school names are often truncated. Some level of data preparation is required before data is analysed for insights.

The CSPD data hub receives and stores data from a number of data sources, measures (quantitative) and dimensions (qualitative labels) from the school system's legacy records. These include a host of demographic variables related to students and schools – gender, ethnicity, language backgrounds, socio-economic status (or its derivative), the school's ICSEA (the Index of Community Socio-Educational Advantage), as established by ACARA (the Australian Curriculum, Assessment and Reporting Authority), geographic location, student attendance, as well as student achievement in external standardised tests and school-based assessments.

For example, data is extracted from the student management system (Compass) and associated professional learning portals for analysis and triangulation. The data for the six lenses is drawn from a number of internal and external sources. Internal sources are typically enterprise-wide source systems such as those that are already in place for student information, finance, payroll and human resources.

External sources include national and state agencies, boards, curriculum and assessment authorities, education and technology partners and service providers. Also, multiple measures are more representative of the phenomenon of interest, and thus cannot be meddled with or produce misleading results as easily, as is more likely the case when using a single measure.

The data and analytics strategy was initiated in 2016 to discover trends in data using new age tools such as Alteryx and Tableau. Until then, data was in spreadsheets, often with the service area. The professional development team had heaps of spreadsheets within the confines of their team. Similarly, the Learning team had spreadsheets of NAPLAN and HSC data – often with names and not identifiers, increasing the risk of misspelt names leading to unmatched records.

The data and analytics strategy was aimed to bring all available data to one virtual home – the data hub. Role-based permissions allowed due security of data. It was also underpinned by a self-service mindset. Instead of data collection purely for accountability measures, the leadership focused on school leaders, teachers and classroom-centred instructional changes and educational processes aimed at student achievement and success. Self-service, along with reflective practice, provided higher intrinsic motivation to the educational professionals in schools and proved to be a better lever for school progress than regulatory-focused, external and imposed forms of accountability.

The processes of capturing and blending data-using attributes (in the form of dimensions or measures) are the core work of data analysts who create dynamic data sets. These dynamic data sets are derived from blending data and can be automated as workflows to occur at periodic intervals or in real time (see Figure 7).

Figure 7 provides a summary of commonly used attributes including student, teacher, school, community, curriculum, assessment and technology. Attributes can be **dimensions** (labels, categories, or text) or **measures** (usually numerical values). For example, given names for students are dimensions, whereas reading scores are measures, such as scaled scores ranging from zero to 550.

The analysis identified the features that contribute to student performance. This reinforces the view that the school system (like any other) is heterogeneous in terms of student ability and demographics, teaching quality, and overall subject strengths of schools.

School systems can leverage internal data – operational, transactional and personal – for blending with external data to undertake comparative and benchmarking processes, thus highlighting how such an approach can potentially achieve improved student and parent experiences within the school system, and derive a deeper understanding of student learning from seemingly disparate data sets.

**Figure 7. Blending of data-using attributes**
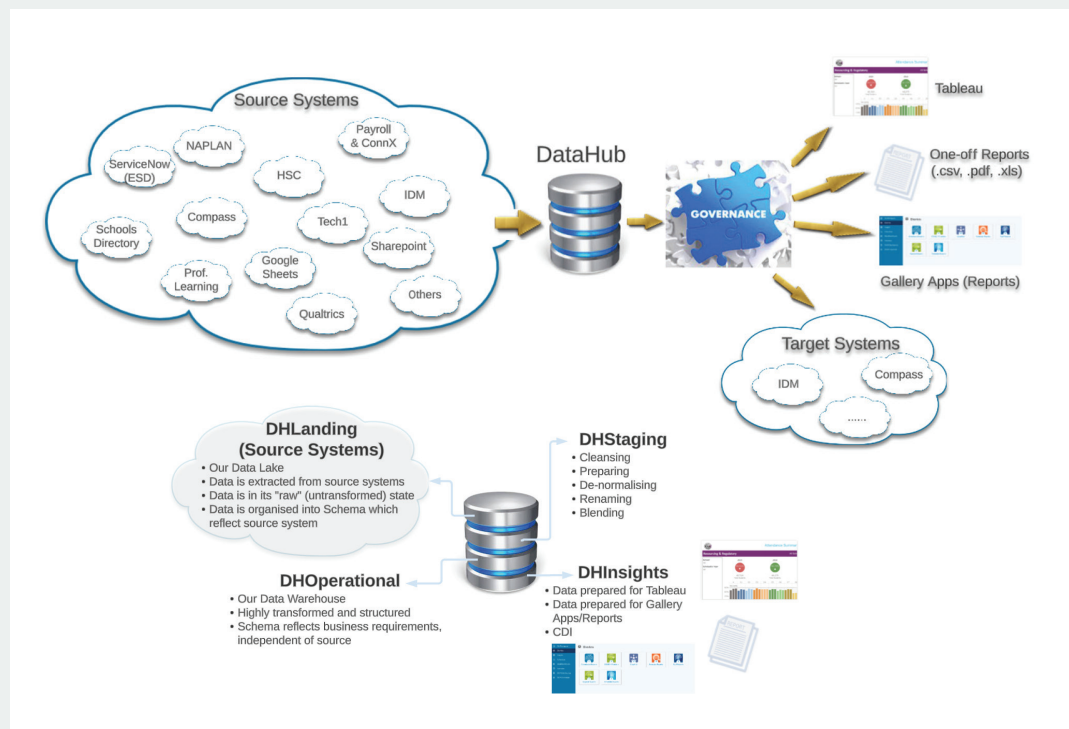
Analytics brought the data to life, made it interactive through visualisations and dashboards, enabled collective decision making for school and system leaders, and generated insights for collaborative action across the school system.

Collected and curated over time, data has the potential to become the transformation lever. Longitudinal data on schools, students, teachers and other such entities, whether individualised or aggregated, provides better 'pulse' of the system.

Given that the policy and regulatory settings in the external environment are common constraints for all school systems in a jurisdiction, data and analytics – with the powerful downstream derivatives of insights, stories and journeys – can highlight the contextual differences between schools and enable more transparent allocation of resources, replacing the formulaic, inequitable ways currently undertaken in most school systems.

Table 3. Types of school system data (not exhaustive)

Type of Data	Data Points (variables)	Data Source	Data Refresh
Student attributes	Enrolment status, date of birth, age, address, ethnicity, parent/guardian contacts, religion, postcode, attendance and leave, medical and behavioural flags, awards, extra-curricular activities, court orders, additional needs, nationality, contact for alerts, refugee status, foster care, visa details, geo location, scholastic year, subjects, scholarships, privacy	Student Information System (SIS)	Daily
Teacher attributes	Employment status (permanent, contract, casual), qualifications, age, address, teacher registration number, service record, experience, leave, conflict of interest declaration, professional learning record	Human resources and payroll system	Daily
School attributes	Address, geo location, school size (maximum capacity and current enrolment), full time and part time staff numbers for teaching and non-teaching staff FTE (full time equivalent), bell codes, calendars for cohort groups	SIS, national and state systems, finance system, payroll system	Yearly
Curriculum attributes	Subjects and courses of study (such as English, history, mathematics); literacy and numeracy domains (such as reading, writing, spelling, counting, place value, etc)	Curriculum authorities, state and national governments, education boards	Biannually
Assessment attributes	Scores, bands, growth points, learning gains, text levels, grades (A–E), teacher comments	SIS and local school databases, assessment authorities, education boards, universities, learning services providers	Daily
Community attributes	Postcode, socio-economic classification, population, population growth rate	Bureau of Statistics, national census, surveys, commissioned reports	Periodically
Finance attributes	Standard funding levels, socio-economic loading factors, learning disability loading factors, resources, school fees, subject fees	Finance systems, fee system, debt management system	Daily
Technology attributes	Device numbers, device types, wireless density, internet usage and access, role based access for dashboard and visualisation, groups and permissions	Identity and access management; databases and servers	Daily
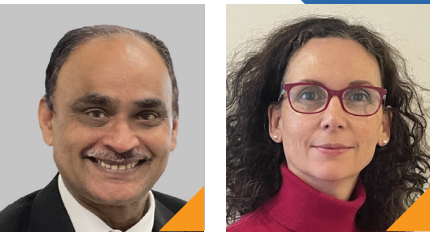
L-R: DR RAJU VARANASI AND GINA PIANTA

About the authors

Dr Raju Varanasi is Director, Data Intelligence and Chief Information Officer at Catholic Schools Parramatta Diocese, with responsibilities that include cloud and networks, enterprise program office, applications and security, data and analytics, enterprise service desk, change management and related user services. With over 30 years of experience in the Australian education system, in both government and non-government sectors, Raju obtained his PhD in Education in 2021, focusing his research on transforming school systems with analytics and systemness.

Gina Pianta has spent almost two decades working in education as a researcher and writer helping to shape a new narrative of schooling in today's world. In her current role she is working on crafting data stories to improve the experience of students, teachers and learning communities. Prior to joining Catholic Schools Parramatta Diocese, Gina worked for many years as a radio producer. She has an MA in International Communications and a Bachelor of Psychology (Hons).

About the paper

The authors present the data journey of a Catholic school system of 80 schools in Western Sydney – a journey beginning in 2016 and maturing slowly over time. They discuss how new technologies (eg, machine learning, predictive analytics, generative AI) and new techniques (data storytelling) have been used in their system, in creative and innovative ways – to challenge mindsets, replace or transform entrenched and unproductive practices, and craft new narratives that underscore school and system progress. They argue journeys and progress tell us more about students and school communities than academic performance. The challenge, they believe, for all K–12 systems, is to educate the **whole** person – mind, body, spirit and character – so that all young people flourish and lead productive lives in today's world.

Leading educational thinking and practice