Maths Pathway at Bayside Christian College: Analysis with PAT-M Data

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Abstract

At Bayside Christian College, we have partnered with Maths Pathway since 2019, in order to target each student at their point of need. During that time, we have seen improvements in students' readiness for Year 11 and 12 mathematics, and some positive NAPLAN results. Our students also sit PAT-M each year, so in this analysis, we scrutinise that data to identify the rate of growth in maths attainment from year to year and whether that growth is more rapid than the stated norms. Moreover, we compare this against Maths Pathway dosage data to probe whether any positive results are associated with usage of the program. In the analysis, we find very strong performance overall, with approximately 1.4 years' growth per year as measured by PAT-M; and we find clear positive associations with Maths Pathway dosage. These findings may be important for other schools facing challenges around differentiation, providing a promising option to investigate to lift outcomes.

Keywords: eLearning, mathematics, personalisation, mastery learning, differentiation, dosage, modules

Background

The School Context

At Bayside Christian College, the journey begins for prospective families with the Early Learning Centre (ELC), which offers both 3- and 4-year-old Kindergarten programs, and concludes in Year 12 with the opportunity to complete either the Victorian Certificate of Education (VCE) or the Victorian Certificate of Education - Vocational Major (VCE-VM).

The Australian Curriculum is the basis for the Years Prep-Ten program and VCE/VCE-VM in the Senior School. An important difference in our program is our perspective. We are Christian and honour our role of assisting parents in educating their children according to biblical values. As such, we seek to provide students the opportunity to explore God's world, develop their gifts and learn about a Christian response to life.

Positioned alongside the Baxter-Frankston Trail, the approximately six hundred students of Bayside Christian College enjoy an attractive, modern school with excellent educational infrastructure. An example of this is the digital technology available to assist student learning, which includes in Primary: interactive screens in learning spaces, a computer room, and several class sets of computers and iPads; in Secondary: a 1:1 Chromebook program for 7-9s, and 1:1 Macbooks for 10-12s; and a College inter- and intranet to support this.

The goal for learning at the College is to support every student to unlock their full potential, including academically. This means meeting each learner at their point of need, and helping every student to grow.

Differentiation with Maths Pathway

At Bayside Christian College, we were aware of Australian research indicating that "in any given year level, there is a five- to six-year difference between the most advanced and the least advanced ten percent of students", with some studies indicating that in mathematics the spread can be as much as eight years (Goss & Hunter, 2015). We recognised this in our school context: we observed that by the commencement of Year 7, the gaps between our student's different capabilities in Mathematics appeared to be at least eight years- with some students

missing understandings from Year 2 and others capable of challenging work at a Year 9 or 10 level.

This is why in 2019, Bayside Christian College began our partnership with Maths Pathway - to differentiate instruction, targeting students at their point of need, promoting mastery, and allowing all students to grow along a continuum from wherever they happen to be. This is implemented in Years 7, 8, 9 and 10.

Maths Pathway is "a sustainable, evidence-based programmatic approach to maximised teacher efficacy in delivering differentiated maths learning for students across Australia … Critical to Maths Pathway's success is the pedagogical model that empowers teachers to use assessments and evidence based pedagogical strategies effectively and efficiently." (Sundar & Schenke, 2021).

Using Maths Pathway involves some use of technology, but is not a mere supplement to instruction. Our teaching teams based the core of their instruction, their course planning, their assessment and their reporting in this model - implementing something cohesive and end-to-end that consistently targets each student at their point of need.

The Basis for this Analysis

School-level Data Observed so Far

Since implementing Maths Pathway, we have observed growth in the capacity of students to take on higher maths subjects, such as Mathematical Methods and Specialist Math in the VCE. NAPLAN growth data also suggested strong growth in Mathematical understanding for students from Years 7-9; however, due to NAPLAN being cancelled in 2020, it was difficult to track this aspect of growth in Numeracy with certainty.

We are interested in further investigating the efficacy of our teaching approach through the utilisation of multiple data sources, specifically: PAT-M growth, PAT-M attainment, and Maths Pathway module dosage.

PAT-M Data Collection

The Progressive Achievement Test for Mathematics (PAT-M) is provided by the Australian Council for Education Research (ACER). PAT-M aims to measure "…what students in Foundation to Year 10 know, understand and are capable of across domains, and help monitor progress over time." (ACER, n.d.). Our students take this test annually around the start to middle of Term Three of the school year (August-September), delivered through ACER's online testing platform.

Maths Pathway Dosage Data Collection

Through Maths Pathway's online platform, students' 'dosage' is recorded year to year. This is a count of the number of 'modules' a student completed during each academic year, with each module typically taking around 30 minutes to complete. This dosage data indicates the extent to which the program was used by an individual student.

Key Research Questions

Drawing upon PAT-M test data and Maths Pathway dosage data, in this analysis, we aim to explore:

(a) how our students' growth over time compares to Australian norms, as measured by PAT-M data; and

(b) whether our students' PAT-M performance is associated with Maths Pathway dosage.

Data Sets

Students with PAT-M Growth Results

PAT-M results from 2022 and 2023 were considered. We looked specifically at results from Year 7 and Year 8 in 2022; and then Year 8 and Year 9 in 2023. Due to some changes in enrolments and some absences on the day of the test, not all data points from 2022 matched with 2023. Only data that matched across both time points was considered so growth across that period could be examined. The resulting data set pertained to 83 students, of which 48 were in Year 7 in 2022 and 35 were in Year 8 in 2022. This captured the large majority of students in these cohorts; the only students excluded were those without PAT-M data available due to absence and/or students who were not enrolled at Bayside Christian College for the relevant time period.

Students with Year 8 PAT-M data and relevant Maths Pathway dosage data

Maths Pathway dosage data from 2021, 2022 and 2023 was considered. Students who were not enrolled at Bayside Christian College during one of those years would not have any dosage data available. In this analysis, we were interested in Year 8 PAT-M performance (a test

common to all students in the data set), so looked at the dosage leading up to that test. That is, during Year 7 and Year 8.

With no unique identifiers common to both data sources, PAT-M data and Maths Pathway dosage data were matched using students' names. In this data set, there were no students with the same first and last names, removing any risk of ambiguity. The matched data was used for all analyses. The resulting data set pertained to 82 students, of which 48 were in Year 7 in 2022 and 32 were in Year 8 in 2022. This captured the large majority of students in these cohorts; the only students excluded were those without PAT-M data available due to absence and/or students who were not enrolled at Bayside Christian College for the relevant time period.

Analysis and Results

Student Growth from Year to Year

The results of each PAT-M test include a 'PAT scale score' for each student. This is effectively a Rasch scale used across each year's assessment. "Scale scores are measured on an interval scale. This means that a difference of 5 in scale scores in the middle of the PAT scale (for example, from 50 to 55) is equivalent to the same difference on any other part of the scale (for example, from 15 to 20 or from 85 to 90)." This allows students' growth to be measured over time (ACER, 2011).

Australian norms show that the Year 7 students are expected to average a PAT scale score of 131.6; Year 8 students 133.6; and Year 9 students 135.4 (ACER, 2022). This means the typical growth expected between Year 7 and Year 8 is very similar to that between Year 8 to Year 9: approximately 1.9 points on the PAT scale. This gives a benchmark that can be used to see

whether students are making at least 1 year's growth per year - by growing by at least 1.9 points on the PAT-M scale between 2022 and 2023.

Examining students' average attainment on Year 7 and 8 PAT-M in 2022, and on Year 8 and 9 PAT-M in 2023, the average growth shown is 2.7 points on the PAT scale. This is substantially higher than the 1.9 benchmark (42% higher), as pictured in Figure 1. If we take 1.9 points to represent 1 year's growth, then we would estimate that our students were making 1.4 years' growth each year.

Figure 1

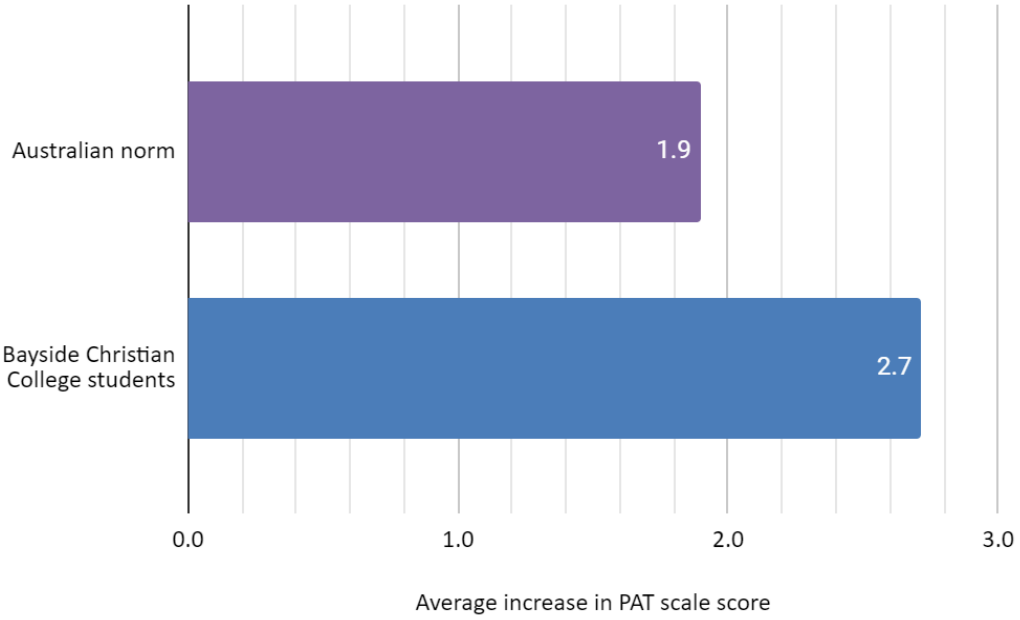

Figure 1: Typical annual growth between Year 7 and Year 9 as measured by PAT-M against Australian norms (ACER, 2022), compared with the measured average PAT-M growth between 2022 and 2023 at Bayside Christian College N = 83 students. This indicates that Bayside Christian College students are growing in mathematical attainment by approximately 1.4 years per academic year.

These results appear very strong. At face value, it seems likely that using Maths Pathway contributed to achieving this success - since it is embedded so deeply into teachers' practice. However, it is worth testing this assumption by checking for associations between PAT-M performance and Maths Pathway dosage.

It is also recognised that the data analysed covered a relatively short period over two years of Math Pathway use. Ideally, to corroborate the initial findings of this report, tracking student data over a longer period would be beneficial. The team would like to revisit the data for at least two cohorts using Maths Pathway from Years 7 to 10.

Student PAT-M Performance and Maths Pathway Dosage

We consider student performance in Year 8 PAT-M. This test is common to all 82 students in the data set, with 32 sitting the test in 2022 and 48 in 2023. For each student, we consider their PAT scale score. We compare this against their Maths Pathway dosage in the lead-up to that test - that is, the total number of modules completed across Year 7 and Year 8 for those students.

We filter students into quartiles by dosage, resulting in approximately 21 students in each quartile. Looking at the distribution PAT scale scores for each quartile, a clear pattern appears to emerge as shown in Figure 2. There appears to be a positive association between students' Maths Pathway dosage and their score on Year 8 PAT-M.

Figure 2

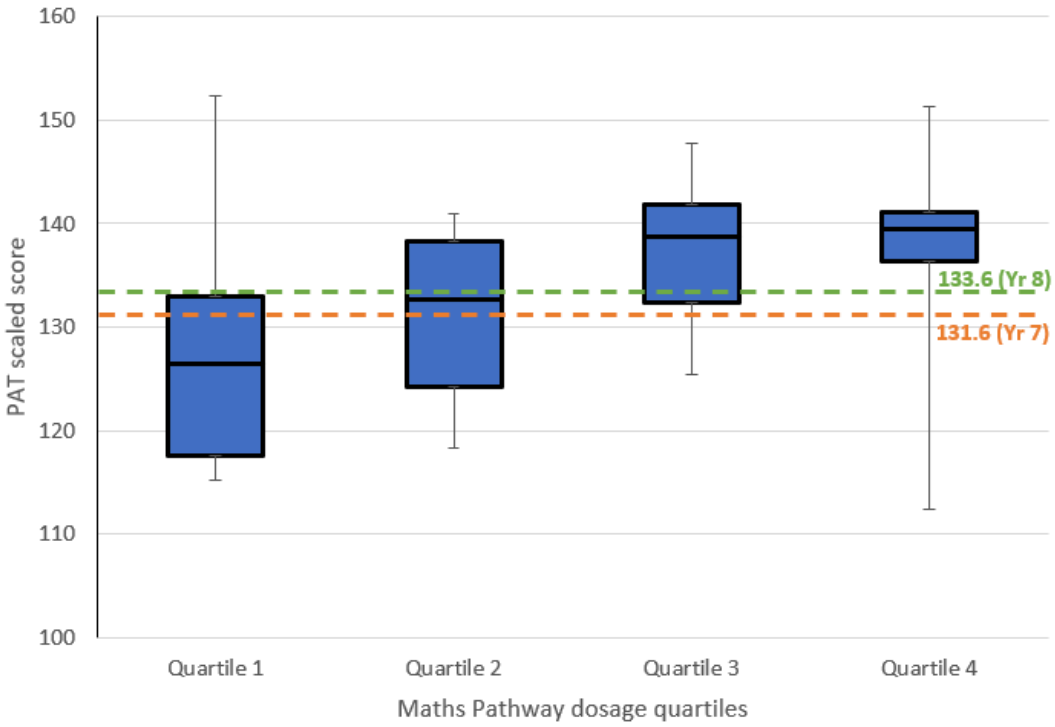

Figure 2: PAT scaled score on Year 8 PAT-M in 2022 and 2023 at Bayside Christian College N = 82 students. These box plots show 5th, 25th, 50th, 75th and 95th percentiles. Students are separated into quartile based on their Maths Pathway dosage (number of modules completed) across Year 7 and Year 8. Australian norm data for Year 7 and Year 8 PAT scaled score averages are shown for reference by dotted lines (ACER, 2022).

Maths Pathway has a guideline for a minimum effective dosage of 52 modules per year. This is equivalent to an average of 4 modules completed per Topic Test across 13 Units in the year. We find that of the 82 students in the data set, 77 (94%) met this requirement. Comparing this "high dosage" group against the other students shows a very noticeable difference in Year 8 PAT-M attainment. Figure 3 shows that the median student in the high dosage group was higher than typical Year 8 attainment. The median in the lower dosage group was substantially lower than typical Year 7 attainment.

Figure 3

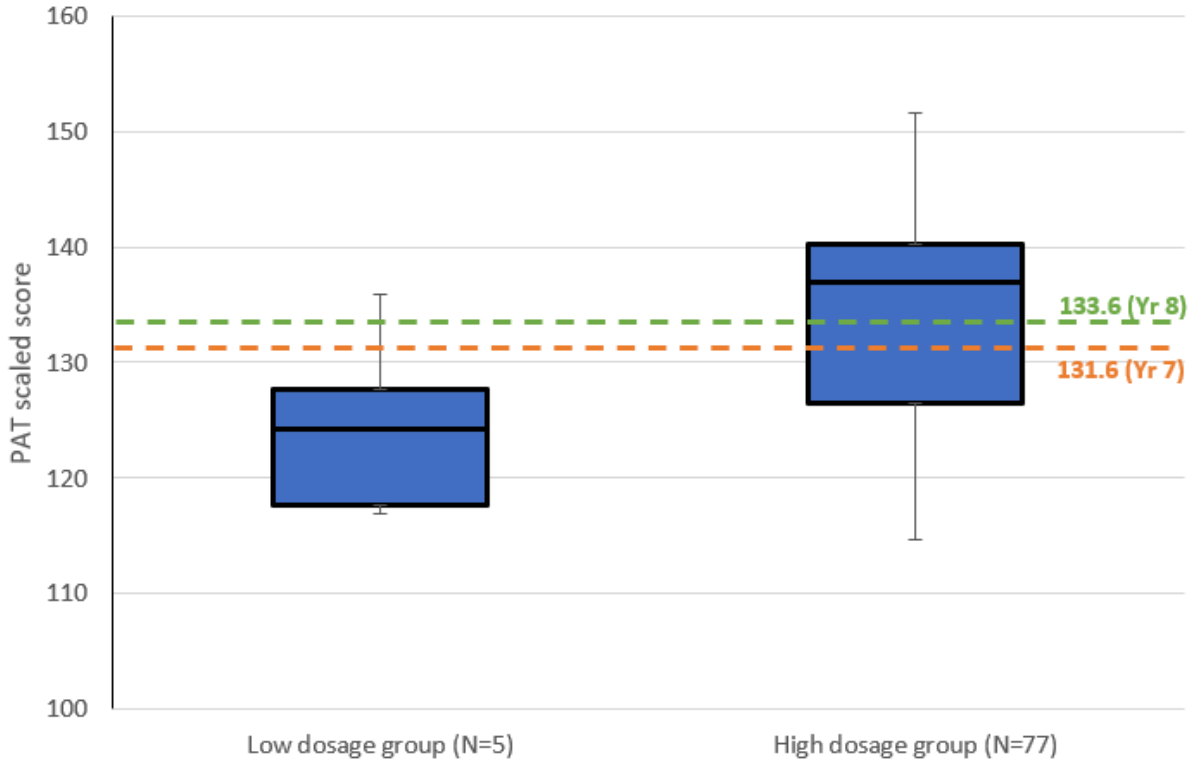

Figure 3: PAT scaled score on Year 8 PAT-M in 2022 and 2023 at Bayside Christian College N = 82 students. These box plots show 5th, 25th, 50th, 75th and 95th percentiles. Students are separated into two groups, based on whether they met Maths Pathway's recommended minimum dosage (at least 52 modules completed per year) across Year 7 and Year 8. Australian norm data for Year 7 and Year 8 PAT scaled score averages are shown for reference by dotted lines (ACER, 2022).

Conclusion

With our implementation of Maths Pathway at Bayside Christian College, we set out to explore (a) whether our students were growing rapidly in maths attainment from year to year; and (b) whether our students' improvement in PAT-M performance was associated with Maths Pathway dosage.

Looking at data for 83 middle school students from 2022 and 2023, we saw that our students appeared to grow at 142% of the Australian norm, as measured by PAT-M (approximately 1.4 years' learning per year). Students with a higher level of use of the learning tool ('dosage') performed better on Year 8 PAT-M than those with a lower dosage. 94% of students met the minimum dosage requirements; and had median attainment lying well above that which is typical for Year 8 PAT-M.

These results indicate that learning growth is very strong at Bayside Christian College while using Maths Pathway. Moreover, the level of use of Maths Pathway appears to be directly associated with that strong performance. The data is consistent with the informal observations of our teaching staff: that with Maths Pathway, they are directly and substantially increasing student learning.

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