ACHIEVING GROWTH IN NAPLAN: CHARACTERISTICS OF SUCCESSFUL SCHOOLS

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Abstract

Since 2008, Australian students in Years 3, 5, 7 and 9 have been assessed through the National Assessment Program – Literacy and Numeracy (NAPLAN). In 2015, the Office of the Chief Scientist commissioned a study into the processes used by schools that demonstrated successful outcomes in NAPLAN numeracy. A team of researchers across Australia conducted a total of 55 case studies in order to identify practices and policies that were consistent between successful schools. Data were gathered through surveys, classroom observations and interviews conducted with school leaders, teachers, students, and parents. Overall findings indicated there were a number of characteristics that were common to schools who achieved sustained growth in NAPLAN results. These characteristics included the development and implementation of policies that specifically supported numeracy learning and teaching, use of a variety of data sources to develop and refine mathematics teaching programs, team planning, strong numeracy leadership and a consistent school approach to teaching mathematics. This paper presents the findings from three case study schools as illustrative examples of how the identified characteristics were enacted in practice. The study has particular implications for policy makers and school leaders who may be seeking ways to develop consistent and effective mathematical practices in their own schools.

Introduction

Established in 2008, NAPLAN is an annual assessment for Australian students in Years 3, 5, 7 and 9. NAPLAN is made up of tests in the four areas of reading, writing, language conventions and numeracy. The tests retrospectively provide diagnostic information to parents, teachers and schools about students' performance in literacy and numeracy topics at the time of the tests (http://www.nap.edu.au/_resources/__NAPLAN_2016_information__for_parents_web.pdf). The content of the tests is aligned with the Australian Curriculum, with the numeracy test including topics such as number, geometry, algebra, function and pattern, measurement, statistics and probability. The results are intended to assist schools to identify strengths and weaknesses in teaching programs, report student progress to parents, identify students who require additional support and also inform the community about school NAPLAN results through the My School website (www.myschool.edu.au). While this is an admirable goal, unfortunately the nature of the testing regime and reporting of the results can create anxiety in the participants (Wyn, Turnbull, & Grimshaw, 2014).

The wider study providing data for this paper was commissioned by the Office of the Chief Scientist (OCS) in 2015. The purpose of the study was to identify schools that had achieved high gains in NAPLAN numeracy during the time periods 2011-2013 and 2012-2014, and to examine their practices in mathematics education. The goals identified by the OCS, and of particular relevance to this paper, included the following:

- To identify state and territory level, system level, school level, and teacher practices that achieve superior gain in NAPLAN numeracy test performance between 2011 and 2013 for

Years 3, 5, 7 and 9
- To identify defined practices in primary and secondary schools that result in superior gain at the state and territory, educational system and school levels
- To understand principals' and their schools' approaches to mathematics teaching

This paper focuses on the identification of school level and teacher practices which have potential to lead to gains in NAPLAN results. Schools selected for the study were considered to have made superior gains indicated by being one standard deviation above the average based on overall numeracy results, compared with like schools and with schools with similar starting scores or performance (for schools in jurisdictions where no gain scores were possible for Years 7-9). Thus many of the schools selected were not necessarily high performing schools, but were 'closing the gap'. The researchers were interested in studying their practices and policies that helped them to achieve gains in NAPLAN results. Brofenbrenner's (1989) Ecological Systems Theory was used as a broad structural framework for the study's design, when identifying factors that might contribute to individual schools' success. In the study, Brofenbrenner's spheres of influence were the system, the school, the classroom and teacher, and the individual student. This paper attempts to answer the following research questions, as related to the different level influences:

- What school level influences are evident in schools with superior NAPLAN numeracy outcomes?
- What classroom level influences are evident in schools with superior NAPLAN numeracy outcomes?

Review of the literature

There is a vast body of research that has considered successful outcomes in schools (e.g., Centre for Education Statistics and Evaluation [CESE], 2015); Schleicher, 2016), school improvement (e.g., Masters, 2010) and effective numeracy practices (e.g., Askew, Brown, Rhodes, Johnson, & Wiliam, 1997); Clarke & Clarke, 2002). A recent study conducted in New South Wales, for example, found that high value-add schools had six factors in place (CESE, 2015, p. 3):

- Effective collaboration
- Engaging and sharing in professional learning
- Setting whole school goals and strategies for change
- Using explicit and effective teaching strategies
- Creating an environment that promotes learning and high levels of student engagement
- Setting high expectations in achievement

The use of data has also been identified as a leadership practice that is related to school-wide improvements in teaching and learning (Masters, 2010). 'Analysis and discussion of data' is one of the eight domains identified in the Teaching and Learning School Improvement Framework (Masters, 2010) whereby outstanding schools are characterised by having established and implemented a systematic plan for the collection, analysis and use of student achievement data. Furthermore, data are used throughout the school to identify gaps in student learning, monitor improvement over time and monitor growth across the years of schooling (Masters, 2010). The Grattan Institute also recommended the use of data to inform teaching through the provision of a checklist of effective uses of data such as a shared sense of responsibility for students' learning; developing a common language across the school; and in-house professional development (Goss, Hunter, Romanes, & Parsonage, 2015).

General factors that influence learning

Hattie (2009) identified over 50 factors that impact on students' learning. His meta-analysis identified six elements that influenced success: the student, the home, the school, the curriculum, the teacher, and the approaches to teaching. Of most relevance to the study discussed in this paper is the influence of the school, the curriculum and the teacher, since no or limited data were collected in relation to

home influences and individual students.
Considering Hattie's school level effects, school leadership was reported as important, particularly leadership that promoted, participated in, and supported teacher professional development (Hattie, 2009). Similarly, the Teaching and Learning School Improvement Framework (Masters, 2010) identified that outstanding practice required the development and implementation of an explicit and detailed local school improvement agenda. School level factors have also been shown to influence mathematical performance, particularly in terms of organisational factors such as class grouping strategies and streaming, along with the socio-economic index of the school (Author, et al., in press).
Although Australia has a national curriculum, its implementation varies across school contexts and teachers may interpret the components of mathematics differently, which impact upon students' outcomes. Individual teachers' decisions in relation to planning and programming, sequencing and resource choices all influence how students learn. For example, Hattie ranked 20 top curriculum influences that included vocabulary programs, repeated reading programs and creativity programs. As an indicator of school improvement Masters (2010) asserted the importance of systematic delivery of curriculum with a strong alignment between the overall curriculum delivery plan, term and unit plans, classroom teaching and the regular assessment of student progress in relation to curriculum expectations.
Teacher effects found to influence student learning include teacher-student relationship, teacher clarity and professional learning (Hattie, 2009). Feedback with clear directions for improvement also has a powerful effect on how students progress (Hattie, 2009). Teacher knowledge and beliefs have also been shown to influence student learning; teachers that have lower expectations are more likely to have students who have difficulties with learning mathematics (Beswick, 2007; 2008). Teacher knowledge has been the subject of research for many years, with a number of studies finding that primary school teachers in particular lack mathematical content knowledge (e.g., Ma, 1999; Ball, Thames, & Phelps, 2008). While there is little evidence that mathematics qualifications alone lead to successful learning outcomes (e.g., Mewborn, 2001), pedagogical content knowledge (PCK) does make an impact on students' learning outcomes in primary schools (Hill, Rowan & Ball, 2005), in middle years (Author, 2015) and high schools (Baumert et al., 2010). Part of teachers' PCK involves knowledge of students and how they learn, making teacher decisions about differentiation and responding appropriately to the need of learners (Masters, 2010) particularly important.

Methodological approach

The research reported in this paper was part of a larger study that used a cross-sectional approach to provide a description of processes used by schools that demonstrated successful outcomes in NAPLAN numeracy (Author, et al., in press). Three data collection approaches were used: a desk-top review of system level provision, surveys of school leaders, teachers and students as well as case studies across all Australian states and territories. This paper considers the results from three case study schools from two states as being illustrative of the practices viewed and reported. Case study methodology was considered appropriate in terms of bringing new understandings to the fore (O'Leary, 2010), and as it is particularly useful for studying complex issues. The study fits the paradigm of case study research in that it investigated a contemporary phenomenon within its real-life context, and used a range of evidence sources (Yin, 1984). Data sources provided richness and depth to the study of the cases, with interviews conducted with school leaders, teachers, students, and in some cases, parents. Ethical approval from all jurisdictions was granted for the research.
The case study schools discussed in this paper were selected from 55 High Gain/High Performance schools. These three schools offer a diverse mix of location and organisational structure which enable insights into a range of school policies and practice associated with the teaching of mathematics. School A is a Tasmanian P -12 independent school; School B is a P – 12 Melbourne metropolitan independent school; and School C is a Victorian P – 12 government school. The schools share a common factor of being P – 12 schools, thus eliminating influences of variability across school levels and allowing variability in location and type. At each school a diversity of participants within each case facilitated the collection of multiple perceptions of the teaching of mathematics. Semi-structured interviews were conducted with the Principal and/or school leader, at least two teachers, a focus group

of students, and in some cases, a focus group of parents. Two 'typical' mathematics lessons were observed and field notes taken.

Interview schedules

Audio-recorded Interviews with school leaders and teachers began with questions related to school context, followed by questions related to policy, school, and class level questions. Example questions included *'How do you manage the NAPLAN process? What do you attribute your success to? How do you utilise the data from NAPLAN to inform the teaching in your school?* Questions that were more generic in nature related to mathematics teaching were also included – e.g., *How is mathematics organised and taught in your school? What characterises an effective mathematics teacher/lesson?* Teachers were asked how they organised and planned their mathematics program, how they prepared students for NAPLAN tests and to describe a typical mathematics lesson in their classroom. Students were also asked to describe a typical mathematics lesson, how they felt about mathematics and what their experiences of NAPLAN testing had been like.

Participants and procedures

The number of participants and the procedure varied according to different contexts and availability of participants on any given day. In School A, for example, interviews were conducted on the senior campus with the principal, the head of mathematics who also taught the Year 9 lesson that was observed, two Year 9 students and four parents. The interviews with the students and teachers all occurred on the one day, with the parent focus group interview being scheduled for another day. The junior campus interviews were also conducted on another day and involved the school leader of the junior campus, a classroom teacher and two Year 6 students. Table 1 shows the number and type of participants from each of the three case study schools referred to in this paper.

Table 1. *Number and type of participants and lessons observed for each case study school*

School	**Interview participants**	**Lessons observed**
School A	Principal 2 school leaders 2 classroom teachers 2 Year 6 students 2 Year 9 students 4 parents	Year 9 Year 6
School B	Principal Head of maths/science 2 Year 7 maths teachers 12 students	Year 7
School C	Principal P-12 numeracy coordinator Year 3 teacher Year 7 teacher Education support tutor 5 year 3 students	Year 3 Year 7

In all three cases, the Principal was the first person to be interviewed providing an overview of the school's context, mission statement, and values. In addition, individual school information was available and reported from the school website and MySchool Website.

Each researcher (authors) completed one to three case studies within their state. They agreed that the three case studies reported in this paper had similar characteristics to other schools within the larger study. Table 2 provides an overview of the three schools reported in this study including demographic details. The scope of this paper made it difficult to report on more than three schools.

Table 2. *Overview of school's demographic data and NAPLAN numeracy results*

School	Year levels	Sector	Year range	Total enrolment	Teaching staff	ICSEA value
School A	Foundation – Year 12	Non-government	Prep-12	700	90	>1000
School B	Foundation – Year 12	Non-government	Prep-12	500	60	>1000
School C	Foundation – Year 12	Government	Prep-12	200	30	900-1000

Data analysis

The written case study reports were completed using the larger project's reporting template. The reports were descriptive in nature and were synthesised by a process of looking for themes related to school, teacher and classroom effects. Open coding was also used to ensure that any unanticipated factors were taken into account. Due to the tight timeline required for reporting, the interviews were not initially transcribed, but for the purposes of this paper, partial transcription of the three case study schools has since occurred.

Results and Discussion

This section has been structured to consider Hattie's (2009) identified effects observed at the school, teacher and classroom levels.

School level effects: Organisation and policies

In close examination of the data from the case study schools a number of key factors emerged. These are summarized in Table 3, whereby the presence of factors are indicated (x – not evident; √ - evident; √√ - very evident), and further expanded on below. Of particular note, and prominent in all three schools were: specific school policies supporting the teaching of mathematics; employment of qualified teachers of mathematics; catering for individual student differences; and minimal emphasis on NAPLAN.

Table 2. *Overview of factors common to case study schools*

Attribute	School A	School B	School C
Collaborative planning	√√	√	√√
Differentiation	√√	√	√
Small classes	√	√	√√
Set text	√√	√ √	X
Remedial support	√√	√	√√
Employment of qualified mathematics teachers	√√	√	√√
Numeracy leader	√	√	√√
Minimal preparation for NAPLAN	√√	√ √	√
Range of tools used to assess with students	√√	√ √	√√
High expectations of students	√√	√ √	√√
Purposeful use of NAPLAN Data	√√	√ √	√√

How mathematics was organised varied between schools, but all were characterised by the development and implementation of policies that specifically supported numeracy learning and teaching. At School A, for example, coordinators for each curriculum area were appointed for each campus. Collaborative planning occurred in year group teams. As a result each year level undertook similar topics of mathematics at the same time, with the provision to extend individual students.

Classes were kept reasonably small, with the four Year 7 classes, for example, being split into five groups for mathematics. Group sizes were typically larger in the top classes as the lower ability classes required more support and according to the principal, "is another structural consideration that is important."

School C, implemented a whole school approach to teaching mathematics with the staff developing a scope and sequence document including Early Years (Foundation – Year 3), Middle Years (Years 4-8) and Later Years (Years 9-10). The document mostly focused on number with other areas currently being developed. The numeracy co-ordinator said:

> Although it [our scope and sequence] is based on the Australian curriculum as teachers we make decisions about where topics fit…. We state at each level what the teachers should focus on such as addition mainly in Year 1… Year 4 focus is decimals, introduced day one of first term, even though it is difficult, the kids have more exposure, rather than waiting until the end of the year to cover the topic…. it is not linear but we make connections to other topics…we build understanding.

Employment of suitably qualified mathematics teachers, collaborative planning and support for teacher development were factors that helped to achieve consistency and best practice in the three case study schools. School B, for example, had a deliberate policy of only recruiting suitably qualified teachers in mathematics/science with some years of experience, and there were no graduate teachers at the school. School C also only recruited qualified mathematics teachers and had a strong mentoring program in place, whereby new teachers were mentored weekly for the first term then informally for the rest of the year, with first year teachers being mentored for the whole year. Within School C, all teachers worked and planned with each other, each having a desk in the staff room. Teachers belonged to triads and were part of mixed learning teams. Teachers also belonged to professional learning teams and worked together to meet their school and personal goals. Due to the rural location of the school, staff regularly provided professional learning to each other as five minute snippets of something that worked for them. The numeracy teacher planned with different teachers during the year, regularly taught with teachers, and then collaboratively reflected on mathematics learning and teaching.

Differentiation was another common key characteristic evident in the data from these case study schools. Sometimes differentiation took the form of streaming, whereas in other situations, groupings were more flexible and fluid. The Principal from School A, for example, indicated that there was rudimentary streaming that occurred at the Year 7 level, and the Year 5 and 6 levels were also grouped according to ability. The Principal preferred to talk about grouping and differentiation, rather than streaming and positioned this practice as catering for the differing needs of students:

> We realise that there are students in Year 6 and even earlier who are yearning for extension, and that's where we make sure that we are catering for those students appropriate to their level, from an early age – student differentiation … and equally for students who need remedial type assistance that we identify that at the earliest stage possible – so that's our policy – to cater for students according to their needs, rather than their age.

This was also reinforced through School A's junior school leader's following comment:

> One of our other priorities within our school improvement plan is differentiating our learning and very genuinely catering for individual needs so we have quite strategically set ourselves up so that we have fairly small classes, we have a very good teacher and teacher assistant ratio, … and we are very passionate about having individual learning plans … so then we have targeted intervention within the classroom setting but we also have one on one opportunities and some small group activity as well and yes, we are very passionate about that and as it says in our strategic plan, that every child does reach their potential and we are very committed to not one single child slipping through.

In terms of differentiation in School B, the principal claimed that individual differences were catered for in a variety of ways according to their needs:

> Students are recommended by the teacher … every child on the list is assessed. Where is the progress? What testing needs to be done? What follow up? What communication with

> the parents? What referral system?… [There is] a special needs enhancement co-ordinator … and there are a couple of students who have been accelerated with old boys [previous students of the school] as mentors … in a support situation of some past students to fix up where the gaps are... Where children were not achieving particular benchmarks, what do we now do to engage them and enhance their learning? For some it might mean additional homework club, 20 minute spot fire blasts … you will see the maths teachers here always helping kids at lunchtimes.

The Principal at School C also emphasised that, "We make sure we differentiate, focus on English and numeracy as the most important subjects and the other subjects are a vehicle for teaching English and numeracy". In addition this school had two intervention programs that were used to support students with numeracy difficulties.

In all three schools, there was a coherent and focused approach to catering for students' mathematical needs in line with earlier research findings (e.g., CESE, 2015; Masters, 2010). Leadership was clear, but often devolved through professional learning teams who had carriage of curriculum implementation. Ongoing professional learning was one factor identified by Schleicher (2016) as an important component of teacher professionalism.

School level effects: Emphasis given to NAPLAN

Participants at all three schools stressed the lack of emphasis on NAPLAN in their school. NAPLAN results were seen as part of a suite of useful data to be considered in the design and content of mathematics lessons. According to the Principal of School A, for example, the NAPLAN tests were not managed in any particular way:

> … rather it is the mathematics teaching – we have some very skilled mathematics teachers – it is a very capable and cohesive department – well led and one which thrives on excellence – there is an expectation throughout the school that staff will go the extra distance to assist students.

The Principal also reported that:

> There is no direct teaching to the test – there's preparation questions so that they know what they are doing which we would be negligent if we didn't do that but there's no coaching for the test – it is just part of what they do.

This view was substantiated by the senior school leader:

> Look I'm pretty proud of the school – we don't do any special preparation for NAPLAN – it's good that the school feels robust enough in their own self belief that they think we're doing an all right job so we'll just give them the test and hopefully they'll do all right and if they don't, then well cest la vie - the one thing we might do is just show them a test so that the format doesn't freak them out.

The parents also saw NAPLAN as not being a big focus in the school, acknowledging that "they used to do some practice so that they were kind of aware of the format". This approach seems to have resulted in students' not being overly anxious about the tests as the following student comments show:

> I was actually really excited – I was looking forward to it. [Bridie[1], Year 6 student]

> I wasn't that worried 'cause I was thinking that it wouldn't matter that much if I didn't do well as it wasn't going towards my report. [Beth, Year 9]

The Principal, head of Mathematics/Science and the teachers from School B, all expressed the view that NAPLAN was just one of the measures used to identify particular students needing additional support:

> We had a meeting a few years ago about NAPLAN and decided not to get too paranoid about it … we looked at the structure … and we made sure kids were exposed to those sorts of things but we weren't over paranoid about it so we only give kids in the week leading up to NAPLAN a previous year's NAPLAN to familiarise them with the structure

[1] Pseudonyms used throughout

> but we try with in our teaching to expose kids to [interpretation of] graphs and diagram because we believe maths you interpret information … [Head of mathematics, School B]

In School C, NAPLAN was taken seriously but all interviewees agreed that it was only one test that was taken on one day. As with schools A and B, the focus was more on familiarising students with the test structure, rather than practicing individual items. In the middle years students' homework included revision and preparation for NAPLAN type questions or sample NAPLAN tests. Students also completed a range of other assessment tasks including the Progressive Achievement Tests.
In terms of utilising data from the tests, all three schools indicated that this occurred in a systematic way. For example, the junior school leader from School A explained the approach in the following way:

> The collection and analysis of data is one of our priorities for the next two years, and building our capacity around that - we use whole school information, then cohort and individual information to guide our practice and we start utilising that data as quickly as we can in that same year, in preparation for our planning for the following year.

Similarly, the Head of School from School B indicated that purposeful use was made of the NAPLAN data:

> When we get the results back we get a breakdown of each child how they are performing [and make individual plans for some children] … we look at the rest of the data and make sure we give an emphasis on [a particular] topic [if necessary]. [Head of Mathematics/Science]

In addition, the results from the primary campus were given to the secondary campus teachers to provide them with an understanding of students' prior knowledge to assist in planning for their needs.
In School C, NAPLAN data were analysed by six subgroups of staff, across different domains and priorities were identified accordingly. When analysing the latest NAPLAN data, for example, the subgroup found that most students had improved but:

> The bottom Year 7-9 students were stopping or going backwards… we need to look at how we run these programs… we currently have GRIN [Getting Ready in Numeracy] and QuickSmart for these students and other intervention activities but we are now consider changes to how we teach Year 9 and 10 next year… maybe team teaching with both of us and a teacher aide. [Numeracy coordinator]

The above comments show evidence that all three schools had a coherent approach when analysing and making use of school data, particularly in terms of identifying gaps in students' learning and monitoring growth over time (Masters, 2010). This was also a theme in the next section, teacher and classroom level effect data.
The relatively low-key approach to NAPLAN taken by all three schools may help to reduce the reported stresses experienced by teachers and students about the testing program (Wyn, et al., 2014). The use of NAPLAN data, however, in conjunction with other information about students is in line with the suggestions of Goss, et al. (2015).

Teacher and classroom level effects

As mentioned earlier, a strong alignment between the overall curriculum delivery plan, term and unit plans, classroom teaching and the regular assessment of student progress in relation to curriculum expectations has been identified as an indicator of outstanding school improvement (Masters, 2010). This was evident in School A's case through the focus on collaborative team planning, high but realistic expectations of all students and consistent approach to teaching. The Principal identified good classroom practice as a measure of success in the following way:

> Good maths classes – teacher-focused but a quiet confidence in the room that they are being taught by competent able professional teachers – and the students are quietly confident – it's settled, it's calm and as I often say – it's a simple equation – the teachers

> are there to teach, the students are there to learn and that's generally what happens at [School A].

The Principal and teachers interviewed from School B similarly expressed the importance of positive expectations for achievement, with a strong emphasis on pastoral care and progress for all students especially building confidence.

> The more they see you are dedicated, that you are willing to give your all for them, to miss time from your lunch to help them, and you are willing to stand by them and explain time after time. If they see that then they are willing to come to you eventually … if you let me help you then you can get the better results. [Principal, School B]

Like many schools, School C followed an instructional model with each mathematics lesson beginning with a clear learning intention. According to the Principal:

> Over a period of time we have looked at thinking about thinking and metacognition and other dispositions and chose to focus on thinking and embedding thinking skills in the curriculum … the staff are expected to think strategically about their questioning, choosing both open and closed question types and the Bloom's verbs. [displayed in every classroom].

The students were also expected to refer to these during their lessons. In School C, the teachers were expected to take risks when teaching, and as the numeracy co-ordinator said:

> Rather than start at the start of a topic we jump in the middle and try and teach around it… teachers need to be organised and use data properly… get students to do most of the work during the lesson, less [teacher] talking.

The school also considered different ways of assessment:

> We have taken Maths300 tasks and developed assessment rubrics that we can use to assess students and application of skills….we look at effort as part of their assessment as well and want to see how far they go [mathematical understanding] when doing the task… assessment needs to be effective. [Numeracy co-ordinator, School C]

Lesson observations in School A also showed that there was a consistent approach to the lesson structure but one that would be considered 'traditional' in the sense that lessons were teacher dominated and planned using specific school selected resources. Both the Year 9 and 6 lessons observed began with a whole class demonstration by the teacher, an explanation of the tasks to be completed, individual completion of problems from the prescribed text book with regular 'reviews' throughout the lesson. In the reviews, targeted questions from the textbook were shared on the board, students were asked to contribute to ways to solve the problems and then resumed their work by completing further examples. The teachers and students who were interviewed after the lessons indicated this lesson structure was typical.

The junior school leader emphasised that collaborative planning was integral to the consistent way in which mathematics was taught throughout the school:

> Each of our teams – the 3/4 team and the 5/6 team work very closely together and have a consistent approach– it's not just one teacher doing something that's not necessarily related to what the other classes are doing.

A typical lesson in School B appeared to be whole class focused with the teacher explaining and using the board, followed by individual student work from textbooks while the teacher roamed, providing individual assistance.

> Every lesson we have our teacher will write/explain everything we are doing on the board, so everything she says she will write on the board and she will get us to copy it down in our books and for the last 10 minutes of the lesson after she has finished explaining the unit she'll get us to do the homework in class and if anyone is having trouble with it she will go around and help them with it [so that we can finish it off at home]. When we copy it down in our books when we do the homework we can just go back and see how to do that, why is that there, it explains everything. [John, Year 7 student, School B]

In terms of textbook usage, this varied between the three schools. In School A, the practice in the

junior school was guided by a set text, but the junior school leader emphasised that this was supplemented by other resources, with a particular focus on the use of concrete materials and teaching for understanding:

> [Students succeed] from [understanding] the basics, there's a lot of hands on, manipulative activities so if the students don't understand the basics, they're not going to understand it as they progress so we're fortunate with smaller classes and support that we can ensure that our children understand the concepts before they move on.

Textbooks were not used in School C until Years 11 and 12, and while textbooks were used in School B, the Head of Mathematics/Science reported that teachers used different approaches and resources to supplement textbook usage (within the constraints of parental expectations):

> We don't just stick with the textbook we try to do different things [such as] the task centre kit. … We try to do a nice mix. … I don't think textbook is the only way. … but parents expect us to use it [textbook] especially for structured homework. [Head of Mathematics/Science]

Continual monitoring of the appropriateness of the resources used was referred to in School A. The junior school leader indicated that a consistent approach was the key, and that review was an ongoing process:

> We know that to improve student outcomes we need to have consistent practice across our campuses so that's definitely one of our goals and that's why we are currently reviewing what we are doing at the moment – part of an ongoing process – and making sure that the resources that we are using match our practice.

Finally, all three schools were characterised by a genuine commitment to learning, with teachers and students generally demonstrating a very positive outlook towards the teaching and learning of mathematics. Sarah, for example, a Year 7 teacher from School B, indicated that:

> To me [maths] is just having fun with the numbers and that's what I try to do with the students as well … the white boards, a bingo game, the battleship game for co-ordinates … I think the love of it [maths] is the main thing … It's [teaching] so much fun I love it.

The students interviewed were also positive about mathematics and saw it as relevant and important, even when they acknowledged that they were not particularly 'good at maths':

> I think I'm like an average person at maths – like I think I'm not like when I get to the hard stuff, I don't like zoom through it or get it straight away like I actually have to think about it – and I really like algebra because I'm not too bad at it. [Beth, Year 9, School A]

> I do love maths quite a lot because I have improved in it since I came here. One reason I love it is because it's fun. It just depends on how you look at it. From my point of view I find it really fun and exciting to do. [Andrew, Year 7 School B]

They also appreciated that their teacher liked mathematics and liked to provide them with challenges in mathematics:

> Mr X likes to see us have no idea of what we are doing – he doesn't tend to see us stuck – but most of us in the class like to have a challenge that takes a little longer to work out. [Bridie, Year 6, School A]

The importance of working through mathematics problem was also evident in students' comments from School C:

> If you are having trouble with maths, you can ask them for help but they are not allowed to tell you the answer. Sometimes we ask a friend, can you help me with this a little bit but don't tell me the answer … tell me how you worked it out but not the answer. [Erin, Year 3, School C]

In summary, teacher and classroom effects that appeared most influential included a consistent approach to the teaching of mathematics which was achieved through collaborative planning and shared resources. In addition, it was evident from all three case study schools that the school leaders and teachers seemed genuinely interested in mathematics and committed to students' learning.

These three schools, although different in their approach, took a holistic view of curriculum delivery. The curriculum requirements of the Australian Curriculum – Mathematics were considered, as well as the needs of the students, both mathematical and personal. This type of all-round approach is in line with Hattie's (2009) emphasis on the teacher as key in improving student outcomes, The enthusiasm of teachers for teaching mathematics is also important and has been linked with students' increased interest in mathematics (Kunter, Tsai, Klusmann, Brunner, Krauss, & Baumert, 2008).

Conclusions and implications

Since the introduction of NAPLAN, annual assessments of achievement in numeracy and literacy of Australian students in Years 3, 5, 7 and 9 have been undertaken. The focus of this paper is on attributes of schools which have shown superior growth in their NAPLAN results for Numeracy. This paper aimed to identify school level and classroom level effects including a consideration of teachers and mathematics teaching approaches.

The interview data from three case study schools were interrogated to determine characteristics that were common to these three schools that demonstrated examples of sustained growth in NAPLAN results. Most influential characteristics were those related to school wide approaches to the teaching and learning of numeracy such as intentional policies to support numeracy growth, with a consistent school approach to mathematics education and team planning, strong school and numeracy leadership, and use of data from several sources to inform the next steps for improving student mathematics outcomes. It is hoped that the identification of these characteristics can assist policy makers and school leaders in their quest to find ways to improve the teaching and learning of mathematics.

The data reported in this paper were illustrative of the data collected from the 55 case study schools, and indicate that a school-wide approach to the teaching of mathematics, rather than NAPLAN in particular, is the determining factor in raising the standards of mathematics teaching and learning with NAPLAN used as just one measure to guide development of curriculum and teaching approaches. This school-wide approach includes strong leadership, and team planning based on evidence from a variety of sources.

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References

Askew, M., Brown, M., Rhodes, V., Johnson, D., & Wiliam, D. (1997). *Effective teachers of numeracy*. London: School of Education, King's College.

Author (in press)

Author (2015)

Ball, D.L., Thames, M.H., & Phelps, G. (2008). Content knowledge for teaching: What makes it so special? *Journal of Teacher Education, 59*(5), 389–407.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., Klusmann, U., Krauss, S., Neubrand, M., & Tsai Yi-Miau (2010).Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. American Educational Research Journal, 47(1), 133-180.

Beswick, K. (2007/2008). Influencing teachers' beliefs about teaching mathematics for numeracy to students with mathematics learning difficulties. Mathematics Teacher Education and Development, 9, 3-20.

Bronfenbrenner, U. (1989). Ecological systems theory. In R. Vasta (Ed.), *Annals of child*

development, Vol. 6 (pp. 187-249). Greenwich, CT: JAI Press.

Centre for Education Statistics and Evaluation (2015). *High value-add schools: Key drivers of school improvement.* Sydney, NSW: Department of Education and Communities.

Clarke, D., & Clarke, B. (2002). *Challenging and effective teaching in junior primary mathematics: What does it look like?* In M. Goos & T. Spencer (Eds.), *Mathematics making waves* (Proceedings of the 19th Biennial Conference of the Australian Association of Mathematics Teachers, pp. 309-318). Adelaide, SA: AAMT.

Goss, P., Hunter, J., Romanes, D., & Parsonage, H. (2015). *Targeted teaching: How better use of data can improve student learning*. Melbourne: Grattan Institute.

Hattie, J.A.C. (2009). *Visible learning. A synthesis of over 800 meta-analyses relating to achievement.* Abingdon, OXON: Routledge.

Hill, H.C., Rowan, R., Ball, D.L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal 42*(2), 371-406.

Kunter, M., Tsai, Y., Klusmann, U., Brunner, M., Krauss, S., & Baumert, J. (2008). Students' and mathematics teachers' perceptions of teacher enthusiasm and instruction. *Learning and Instruction, 18*(5), 468-482.

Ma, L. (1999). *Knowing and teaching elementary school mathematics*. Mahwah, NJ, Lawrence Erlbaum Associates.

Masters, G. N. (2010). Teaching and learning school improvement framework. Available: http://research.acer.edu.au/cgi/viewcontent.cgi?article=1015&context=monitoring_learning

Mewborn, D. S. (2001). Teachers' content knowledge, teacher education, and their effects on the preparation of elementary teachers in the United States. *Mathematics Teacher Education and Development, 3*, 28–36.

O'Leary, Z. (2010). *The essential guide to doing your research project*. Thousand Oaks, CA: Sage.

Schleicher, A. (2016). *Teaching excellence through professional learning and policy reform: Lessons from around the world*. (International Summit on the Teaching Profession.) Paris: OECD Publishing. Available from http://dx.doi.org/10.1787/9789264252059-en

Wyn, J., Turnbull, M., & Grimshaw, L. (2014). *The experience of education: The impacts of high stakes testing on school students and their families*. Sydney: Whitlam Institute. Available from http://www.whitlam.org/

Yin, (1984). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.