Launching Confident Numerate Learners

Peter Wade
Delany College
<pwade@parra.catholic.edu.au>
Ann Gervasoni
Australian Catholic University
<ann.gervasoni@acu.edu.au>
Catharine McQuade
Delany College
<cmcquade@parra.catholic.edu.au>
Catherine Smith
Catholic Education Office Parramatta
<catherine.smith@parra.catholic.edu.au>

This paper explores how a secondary school in western Sydney used educational research as an impetus to change its mathematical education culture over a three year period. Key changes occurred in four areas: leadership; pedagogy; structures for teaching and learning; and mathematical environments. These included increased professional conversations, adoption of a numeracy lesson structure, regular use of manipulatives and open ended tasks and a structured intervention program for mathematically vulnerable students. Critical to the development of these changes were partnerships with a university academic and the CEDP system leadership team as well as school leadership participation in professional learning.

Introduction

The *Melbourne Declaration on Educational Goals for Young Australians* (MCEETYA 2008) recognised that numeracy is an essential skill for students in becoming successful learners at school and in life beyond school, and in preparing them for their future roles as family, community and workforce members. The numeracy continuum, as described by the Board of Studies NSW Mathematics Syllabus for the Australian Curriculum (2012, p. 7), outlines a progression of learning that can be used when observing students working on problems in mathematics from Kindergarten to Year 10. The ability to make informed decisions and to interpret and apply mathematics in a variety of contexts is said to be an essential component of students' preparation for life in the 21st century. So what can be done when evidence presents that students are failing to progress on this continuum despite good teaching and curriculum provision? In 2009, a system of Catholic schools in western Sydney developed a strategic approach to support its schools address this issue.

The *National Numeracy Review Report* (Human Capital Working Group, Council of Australian Governments, 2008) provided the Catholic Education Diocese of Parramatta's (CEDP) System Learning team with research findings and recommendations that would inform the development of a new numeracy strategy for its Diocesan primary and secondary schools. The CEDP investigated various approaches and found that the *Extending Mathematical Understanding* (EMU) program (Gervasoni et al., 2012), in association with teachers using the assessment interview and framework of growth points from the *Early Numeracy Research Project* (Clarke, Sullivan & McDonough, 2002), had been shown to improve children's learning

and confidence with mathematics and enhance teachers' pedagogical content knowledge.

In 2010 the CEPD launched its new numeracy strategy with the *Numeracy Now Project* that was based on these approaches with ten primary and four secondary schools. This paper examines the learning gained during this project by one of the participating secondary schools.

Context for the Numeracy Now Project at Delany College

Delany is a Year 7–12 Catholic co-educational college providing schooling for students in outer western Sydney. The College has an enrolment of 420 students who come from 38 different cultural backgrounds. The College attracts funding under the National Smarter Schools' Partnership—Low SES and is part of the CEDP system of schools.

In 2010 the College was invited by the CEDP to join a pilot program entitled the *Numeracy Now Project* that adopted the *Inquiry and Knowledge Building Cycle* (Timperley, 2008) to inform teacher learning. This cycle highlighted the need for engagement in systematic evidence-informed cycles of inquiry that builds relevant professional knowledge, skills and dispositions. The cycle begins by identifying the knowledge and skills students need in order to close the gaps between what they already know and can do, and what they need to know and do, to satisfy the requirements of the curriculum. As part of this project, CEDP also engaged an academic partner, Dr Ann Gervasoni from the Australian Catholic University, to assist with further developing the Numeracy Now Project strategy and provide professional learning for Principals, Mathematics Leaders, and Specialist Intervention Teachers.

Participation in the *Numeracy Now Project* initially involved the Principal and School Mathematics Leader participating in a six-day professional learning course that focused on instructional leadership in mathematics; development and implementation of a school action plan that was supported by CEDP teaching educators; assessment of students using the Mathematics Assessment Interview (MAI) (Clarke et al., 2002); and provision of the *Extending Mathematical Understanding Intervention Program* (Gervasoni et al., 2012) for students who are mathematically vulnerable.

The professional learning program provided the College with access to research findings and professional learning about the work of highly effective mathematics teachers, instructional leaders and the characteristics of productive learning environments. As part of this process, the leadership team developed an action plan to implement and report upon during their initial year of professional learning.

The development of the team's action plan began with first assessing the Year 7 students' whole number knowledge using the MAI developed as part of two research projects, the *Early Numeracy Research Project* (Clarke, Sullivan & McDonough, 2002) and the *Bridging the Numeracy Gap Project* (Gervasoni et al., 2010). This was the first time that the interview had been systematically used in a secondary school context. The MAI data was most revealing and useful for the leadership team in focusing their action plan. The data demonstrated that many students did not have the whole number knowledge that their teachers assumed, but also highlighted exactly where the curriculum, instruction and class organisation needed to be refined to best enable all students to learn. The MAI data also highlighted that many Year 7 students were mathematically vulnerable in various whole number domains (see Table 1). Table 1 shows the percentage of Year 7 students determined to be vulnerable in each of the four domains at Delany in 2013. These results are typical of cohorts enrolled in the College as evidenced by MAI data collected over a four-year period, 2010 to 2013.

Table 1. 2013 Delany College Year 7 MAI summary data.

MAI Whole Number Domain	% Vulnerable (*n* 88)
Counting	65%
Place Value	82%
Addition & Subtraction Strategies	36%
Multiplication & Division Strategies	60%

Changes in leading mathematics learning and teaching

Key to the success of the *Numeracy Now Project* was collaboration with an academic partner, and support from CEDP in adopting a leadership triad (team) model that included the College

Principal, a teaching educator from the CEDP and one of the College's lead teachers. This involvement of school leadership ensured that the project gained traction (Hargraves & Fink 2006) and was more likely to lead to sustained changes to practices that would become imbedded in the culture of the classroom and College.

From the earliest beginnings of the *Numeracy Now Project*, the Delany College Principal took a hands-on role in leading the project. Attending the *EMU Leading Mathematics Learning and Teaching* course, along with the Teaching Educator and Lead Teacher, was the beginning of a discourse founded in research and peppered with readings provided by the academic partner, Dr Ann Gervasoni. The four CEDP secondary schools involved in the *Numeracy Now Project* in 2010 were breaking new ground, along with the research partner, as the earlier research had not ventured into a secondary setting before this project. An important strategy employed by the team was to introduce the mathematics faculty to accessible academic papers that did not overawe the teachers but stimulated discussion and sometimes vigorous debate. This was an important strategy to ensure buy-in of all stakeholders; imposed change rarely evolves to be sustainable (Hargraves, 2006; Timperley, 2009). Professional dialogue amongst the mathematics faculty was also informed by research which challenged assumptions about the use of assessment data. Using Timperley's (2009) observations, the teachers looked at the MAI data through a different lens and asked the question, "was the data more about the students' knowledge and understandings or was the data stimulating questions to reflect upon teacher effectiveness in aiding students' progress on the learning continuum?" Timperley and Parr (2009) argue that

> …making such changes is complex. Not only are changes in professional knowledge and skills of the use of assessment data required, but teachers also need deeper pedagogical content knowledge so that they are able to respond constructively to what the data is telling them about changes needed to their practice (p. 24).

In leading a faculty of very able and experienced mathematics teachers, the team decided to use the Inquiry and Knowledge Building Cycle as a segue to explore The Australian Association of Mathematics Teachers' *Standards for Excellence in Teaching Mathematics in Australian Schools* (AAMT, 2006). The call for a deeper Professional Knowledge in Domain 1 evoked conversations around how students learn mathematics and how indeed the mathematics teachers could enhance mathematics learning.

A significant moment in the learning journey occurred in the latter half of the first year of involvement in the *Numeracy Now Project* when one of the members of the mathematics faculty summed up a discussion about the use of the MAI data when he said, "We cannot possibly proceed with our programming for next year's Year 7 cohort unless we know what they know and can do."

Domain 1.3 (Knowledge of Students' learning of mathematics) in the AAMT standards helped the teachers and the team rationalise the need for new ways of knowing and new ways of teaching that in turn called for change.

> Excellent teachers of mathematics have rich knowledge of how students learn mathematics. They have an understanding of current theories relevant to the learning of mathematics. They have knowledge of the mathematical development of students including learning sequences… (AAMT, 2006, p. 2)

Further work by the team saw an investigation of Kagan's (1985) co-operative learning model. Moving from a competitive individualistic approach in achieving learning goals to a model where students worked together to accomplish shared goals required professional coaching. Workshops were planned together by the team and professional learning was delivered by the teaching educator. The teachers were encouraged to employ the strategies in their classrooms and in the combined double lesson. These lessons incorporated a warm up activity, rich tasks and learning reflection. Students worked in teams to solve complex real world problems. One such double lesson saw students literally running to stations located throughout the College in an 'A-Math-zing Race' style of learning. The enthusiasm shown by the students exemplified the attitudinal shift that was taking place for both students and teachers.

Another area of inquiry that the team pursued was student and teacher efficacy in mathematics. A survey was developed and administered to gauge a wide range of responses including attitude about and relevance of mathematics. The

following data (Table 2) is a snapshot of some of the survey data of the first student cohort involved in the *Numeracy Now Project*. The data demonstrates that after a year at the school, the students were much more likely to appreciate the relationship of mathematics learning to everyday life and to its usefulness when they leave school.

Table 2. Percentage responses from students about their attitudes to mathematics.

Survey statements	Year 7 2010 (n=75)	Year 8 2011 (n=75)
In my maths classes we relate what we are learning to everyday life.	68%	91%
I enjoy giving things a go in maths even if I don't know if they will work.	76%	84%
The maths I am learning will be useful to me when I leave the school.	89%	98%

Another significant learning for the team was influenced by the work of Robinson (2007) who asserts that when one sets a goal, it must be 'resourced strategically' in order to maintain the goal as a priority and to best ensure its success. The team resourced the *Numeracy Now Project* in a number of ways which included: funding of a Lead Teacher (Numeracy); prioritising of lesson times and rooms; designated EMU specialist rooms; meeting time for professional learning and planning; training of Specialist EMU Teachers; Leadership training for Lead Teacher, and acquisition of resources available for every mathematics teaching space.

Sustaining change, including planning for succession and engaging in a continual cycle of improvement, has been an ongoing feature of the work of the team. The CEDP's strategic plan, drawing on the work of Robinson (2007), cited in its Theory of Action, requires the development of an annual implementation plan. This plan, together with the Success Criteria, developed by the CEDP Numeracy Team, has provided the tools for the College to engage in frequent reflection and evaluation.

Emerging changes in mathematical environments

Hattie's (2009) synthesis of over 800 meta-analyses relating to achievement, has also informed the work of the classroom teachers at the College. Teachers, knowing that they 'make a difference', have gained confidence in using the growth points for planning for and observing student achievements, become more willing to engage in co-teaching and frequently used 'critical friends' to provide feedback about their teaching. Dr Ann Gervasoni acted as a critical friend and spent some time in the College in 2012 engaging in instructional walks (Sharratt & Fullan, 2012) observing teacher practices and student engagement. The teachers all commented that they found her feedback extremely valuable and practical. As well as changing pedagogical practices from teacher centred to student centred learning using open-ended investigations, teachers have become more proficient in differentiating the learning for their students. They have been aided in this work by regularly using the differentiation planning grid, provided by Dr Ann Gervasoni, that included the following components:

- Brief description of the activity
- What is the mathematics?
- What is the growth-point focus?
- What do you want students to notice?
- Teaching adaptations
  —easier/more challenging
- Teacher questions to probe for understanding.

The mathematics teachers have also been developing their 'on the spot questioning techniques', aiming to assist student articulation of their thought processes, for example, "How do you know?", "Prove it!", "Explain how you know?". This powerful questioning gives both the teachers and students greater awareness of the students' mathematical knowledge and understanding. It creates feedback for the teacher which informs them how to progress the student from their Zone of Proximal Development (ZPD) (Vygotsky, 1978).

The deep questioning has also assisted the teachers to plan and deliver lessons that engage the maximum number of students in the maximum mathematical experiences for the maximum time.

One effective practice that emerged from this understanding was the collaboration between teachers to co-plan and co-facilitate the double

lesson for the Year 7 cohort that occurred once a fortnight. The practice was first modelled by the Lead Teacher and the CEPD's assigned Teaching Educator. Through strategic resourcing and mentoring, the team ensured practical support and regular feedback for the development of this innovation. The traditional classroom environment is now more productive and supportive of student learning through the use of word walls, posters and easy student access to materials that aid their thinking and learning.

Creating opportunities for students to peer teach and to explore rich open-ended tasks in small group settings represented another major shift in pedagogical practice. Teaching strategies that were particularly useful to assist active student involvement in the learning enterprise included: Inside-outside circle, Jigsaw, Graffiti, Think-Pair-Share and Three Step Interviews.

An additional instance of team work that has emerged in the last two years has been a closer partnership between the class teacher and EMU Specialist to share information about specific student's learning needs and to plan and co-teach the activities needed to accelerate their mathematical progress.

Working with parents and the wider community

Parents continue to be acknowledged as one of the key factors in their child's learning. Through the work of the *Numeracy Now Project*, the team has raised the profile of the importance of parents supporting the development of numeracy skills. Since 2010 the College has used a variety of opportunities to encourage and support parents to actively assist their child's further numeracy development wherever possible in their daily experiences. This has occurred through:

- advice and information via the college newsletter and the student diary;
- workshops for parents of EMU students; and
- the display of concrete materials at parent information evenings, open days and
- student–parent–teacher conferences.

Changes in structures for teaching and learning

Dr Ann Gervasoni encouraged the team to plan for activities and professional learning that would act on Recommendations 1 and 12 from the *National Numeracy Review Report* (Human Capital Working Group, Council of Australian Governments, 2008). Specifically these two recommendations made it clear that all teachers, no matter what year level or subject specialty, should acquire mathematical pedagogical content knowledge. To this end, the team continued with some preliminary work that had begun a year earlier in 2009 to enrich all staff members with a fuller understanding of their role as teachers of numeracy. Professional learning workshops have been held since 2010 with all staff focussing on different aspects of the *Numeracy Now Project* work including: the MAI instrument, the Growth Point Framework, and the MAI data and its implications for student learning in all Key Learning Areas (KLAs).

The team planned, from the outset, to develop a 'numeracy across the curriculum' teaching and learning disposition. Professional learning was undertaken to create awareness that every teacher is a teacher of numeracy. 'Numeracy moments' were identified and mapped in all KLA programs by the teachers. This mapping activity highlighted a number of numeracy skills common to all KLAs. At a series of workshops members of the mathematics faculty shared with their colleagues the pedagogical content knowledge needed to effectively teach numeracy skills commonly used across the KLAs. The mathematics teachers have remained connected with their assigned KLA expert adviser on mathematics in the curriculum.

Conclusion

The team at Delany College believe that the work undertaken to better meet the needs of all mathematical learners has implications for many secondary school leaders and mathematics teachers.

Through the work in implementing the *Numeracy Now Project*, it has become evident that the following practices are worthy of consideration by those undertaking similar projects.

1. Devise or adopt a framework of inquiry and knowledge building.

2. Use research to inform the framework of inquiry.
3. Build a 'team' to lead the project which has expertise and spheres of influence.
4. Form powerful coalitions with academic partners and Professional Learning Communities at system level.
5. Strategically 'hook' the hearts and minds of all stakeholders.
6. Lead the community of teacher learners with precision to engender confidence in undertaking the challenge that change brings.
7. Resource strategically.
8. Plan for succession to sustain changes in culture.

One indicator of the success of the *Numeracy Now Project* at the College has been the change to teacher practice. One specific practice has been the programming for effective mathematics learning and teaching. The teachers are more cognizant of using student data, particularly the MAI data each year, to inform adjustments to the teaching plan and cycle of learning. As each Year 7 cohort commences, the process begins anew by:

- knowing the individual student's ZPD by using a diagnostic tool to assess the student's mathematical understandings and to program an appropriate course of teaching;
- knowing, through a structured numeracy lesson, that student reflection and response informs teaching adjustments to ensuing learning activities;
- challenging the learners with problems which create 'hard thinking' within a student's ZPD and provide mathematical thinking strategies and prompts to allow for multiple hits in understanding new concepts.

This new way of working has brought about some profound changes to student attitudes and learning behaviours. As two teachers recently commented,

> There are less students opting out of mathematics class work. The frequent use of concrete materials and investigations using teamwork has promoted student self-esteem, encouraged risk taking and enjoyment of the learning.

> It has been a truly exciting journey and my rewards are received every day on the smiling faces of the students, keen and eager to come and learn—that magical moment when the light goes on.

Students, when asked their opinion about the way in which they are learning mathematics, made the following comments.

> I like our lessons very much because we are learning things and figuring out what to do. I now have more ways of doing maths. In class now, I am more confident to try a question.

> My maths lessons have helped me get more strategies to solve problems. I know a lot more and I'm now not afraid to answer questions.

> I feel confident knowing that I'm not dumb any more. I am smart.

> I like my maths lessons because I've learnt to do things I couldn't do before.

> I didn't like maths in primary school because I couldn't do it. I love maths now. I hate missing a class.

These comments demonstrate the positive impact of the Numeracy Now Project for students and teachers. The College project leadership team, together with the mathematics faculty, believe that the essence of their work is 'launching confident numerate learners'. We are well on the way!

Note

A copy of the extended Launching Confident Numerate Learners paper is accessible on the Delany College website www.delanygranville.catholic.edu.au

References

Australian Association of Mathematics Teachers [AAMT] (2006). *Standards for excellence in teaching Mathematics in Australian schools*. Retrieved from http://www.aamt.edu.au.

Board of Studies NSW (2012). *Mathematics K–10 syllabus, volumes 1 and 2*. Retrieved from http://syllabus.bos.nsw.edu.au/mathematics/mathematics-k10

CEPD. (2013). *Theory of action*. Retrieved from http://www.ceo.parra.catholic.edu.au.

Clarke, B. A., Sullivan, P. & McDonough, A. (2002). Measuring and describing learning: The Early Numeracy Research Project. In A. Cockburn & E. Nardi (Eds), *PME 26: Proceedings of the 26th annual conference* (pp. 181–185). Norwich, UK: PME.

Gervasoni, A. (2002). Intervention and the extending mathematical understanding program: Insights from the early numeracy research project and beyond. In C. Vale, J. Roumeliotis & J. Horwood (Eds), *Valuing maths in society* (pp. 166–181). Brunswick: Mathematical Association of Victoria.

Gervasoni, A., Parish, L., Hadden, T., Livesey, C., Bevan, K., Croswell, M. & Turkenburg, K. (2012). The progress of grade 1 students who participated in an extending mathematical understanding intervention program. In J. Dindyal, L. P. Cheng & S. F. Ng (Eds), *Mathematics education: Expanding horizons* (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australasia, pp. 306–313). Singapore: MERGA Inc.

Hargraves, A. & Fink, D. (2006). *Sustainable leadership*. San Francisco, CA: Jossey-Bass.

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

Human Capital Working Group, Council of Australian Governments (2008). *National numeracy review report*. Retrieved from http://www.coag.gov.au/sites/default/files/national_numeracy_review.pdf

Kagan, S. (1985). *Cooperative learning: Resources for teachers*. Riverside, CA: University of California.

Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) (2008). *Melbourne declaration on educational goals for young Australians*. Retrieved from http://www.mceecdya.edu.au/verve/_resources/National_Declaration_on_the_Educational_Goals_for_Young_Australians.pdf

Robinson, V. (2007). The impact of leadership on student outcomes: Making sense of the evidence. In *The leadership challenge: Improving learning in schools*. Melbourne: ACER .

Sharratt, L. & Fullan, M. (2012). *Putting faces on the data*. Victoria: Hawker Brownlow Education.

Timperley, H. & Parr, J. (2009). Chain of influence from policy to practice in the New Zealand literacy strategy. *Research Papers in Education, 24*(2), 135–154.

Timperley, H., Wilson, A., Barrar, H. & Fung, I. (2008). *Teacher professional learning and development: A best evidence iteration*. Retrieved from http://educationcounts.edcentre.govt.na/goto/BES

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (pp. 79–91). Cambridge, MA: Harvard University Press.