

An Effective Numeracy Program for the Middle Years.

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An holistic approach to improving student numeracy through the implementation of an effective Mathematics program for all middle years students, incorporating problem solving; improving mathematical literacy; information and communication technology and the scaffolding of numeracy concepts in a fully differentiated classroom.

Introduction

Sunshine College is a multi-campus Government secondary school located in the Western Metropolitan Region (WMR) of Melbourne. It was formed in 1991, following the reorganisation of six secondary schools and has an enrolment of approximately 1000 students. It is positioned across four sites and is made up of three junior campuses including a deaf facility and one senior campus. It is a culturally diverse school with more than 50 language backgrounds. The population, in general, suffers a high degree of disadvantage and a low socio-economic position. In excess of 60% of families are in receipt of Educational Maintenance Allowance (EMA) (according to the school's Annual Report 2009).

In general, the majority of Mathematics classes at Sunshine College are teacher directed with the classroom teacher delivering the lesson from the front of the room. The teacher will then complete a number of worked examples on the board, which the students copy into their workbooks followed by various exercises from the Mathematics textbook. Classes rarely use concrete manipulatives; students are expected to work individually; assessment is summative; and the opportunity for modification is limited with weaker students expected to complete fewer examples than the more competent students. On each of the junior sites all students receive four fifty-minute periods of Mathematics instruction per week.

In 2008 and after several years of little or no improvement in data (AIM & VCE), and the placement of several numeracy coaches from the WMR, Yvonne Reilly and Jodie Parsons began to develop an alternative numeracy program.

The Whole School Numeracy Program

The pedagogy of the revised whole school numeracy program is purposeful. The curriculum is derived from the VELS Mathematics continuum and each unit of work is based on understanding the Victorian Essential Learning Standards (VELS) levels of our students as determined by On-Demand data.

This means that in any class we are planning units of work in any given topic area for students from VELs level 2 to VELs level 6, and we are obligated to produce lessons that are differentiated and where every student has not only a point of access but also a stake in the class. We have observed that when our lower ability students perceive of that they are completing the same work as their higher ability peers, positive reinforcement occurs. This is a phenomenon extensively documented by Boaler in her studies of Mathematics instruction in the UK (2001). This approach to planning is a fundamental component of our revised program, where the curriculum focuses on teaching at each individual student's level, providing truly individual learning outcomes.

The delivery of the numeracy program is varied. At times the curriculum is delivered as a whole class investigation with all students generating their own examples and at other times the curriculum is delivered using a range of tools such as open ended tasks, group work, Information Communication Technology (ICT) and the production of artefacts. To accommodate the successful implementation of the numeracy program we have developed a fortnightly schedule as described in Table 1.

Table. 1 Fortnightly schedule for the delivery of a whole school numeracy program

	Lesson 1	Lesson 2	Lesson 3	Lesson 4
Week 1	Scaffolding numeracy	Differentiated lesson	Differentiated lesson	Reciprocal teaching
Week 2	Scaffolding numeracy	Differentiated lesson	Differentiated lesson	ICT

The above schedule is based on four fifty-minute periods of mathematical instruction per week.

The whole school numeracy program is composed of four main areas:

1. Scaffolding numeracy,
2. Differentiated curriculum,
3. Reciprocal teaching
4. Information computer technology.

Scaffolding numeracy

One fifty-minute period per week is dedicated to addressing mathematical misconceptions using the Scaffolding Numeracy in the Middle Years (SNMY) program as developed at RMIT University by Professor Di Siemons and her team

(<http://www.education.vic.gov.au/studentlearning/teachingresources/maths/snmy/projbkgd.htm>).

This body of work addresses the big ideas in the development of mathematical understanding. It moves students from additive thinking to the more efficient multiplicative strategies and beyond to proportional reasoning.

Whilst the program was designed primarily for students in Years 5 and 6, many of our students are entering secondary school well below the expected level. Of the 2010 cohort at our school, 14% were at or above expected level; 36% one year below; 32% two years below, 7% three years below and 11% four or more years below, so the scaffolding program is at an appropriate intellectual level for our students. Alongside the scaffolding lessons we also conduct ‘normal’ Mathematics classes in a truly differentiated way.

Differentiated Curriculum

Two fifty-minute periods of Mathematics instruction per week are dedicated to the delivery of a differentiated curriculum. The structure of each lesson is based on the model described by Rob Vingerhoets for the WMR. Each lesson begins with a warm up activity followed by a five-minute teacher introduction to a student centred activity. The student centred activity, often a group task, provides a rich learning experience and is designed for each student to discover learning for themselves. It also provides an opportunity for the classroom teacher to walk around the room questioning students and teaching explicitly at the point of need. At the conclusion of every Mathematics period, students are required to reflect on their learning either individually or as part of a group.

This format, as described by Rob Vingerhoets (WMR Professional Learning throughout 2009 and 2010) fits perfectly with Kalantzis and Cope’s (2005) belief that experiential learning is informal and that “the best of formal learning accounts for and integrates informal learning into its patterns and routines”(pp38). It is also in line with WMR best teaching practice.

Reciprocal Teaching

One fifty-minute period per fortnight is dedicated to reciprocal teaching. Our Reciprocal Teaching for Mathematics strategy, although based on the model proposed by Palinscar and Brown (1984), has a number of key adjustments described fully by Reilly, Parsons and Bortolot (2009). This revised Reciprocal Teaching is a strategy for improving mathematical literacy where students work in small groups to bring meaning to the mathematical text of written problems. It comprises of four stages; predicting, clarifying, solving and summarising.

Information Communication Technology

One fifty-minute period of instruction per fortnight is dedicated to ICT, although ICT is used wherever possible, this lesson ensures our students have the opportunity to develop competencies for the digital nature of their future.

Assessment

At the beginning of each unit, students are assessed for their pre-existing knowledge of the curriculum, the lessons and the learning opportunities are then planned accordingly. Each student is given a self assessment

rubric which provides them with an opportunity to demonstrate their pre-existing knowledge and to identify areas of deficit. The self-assessment rubric which we call the '*Happy Face*' sheet asks students to tick their level of confidence with a variety of learning criteria. Their ticks are placed on a continuum from 'I don't understand this yet' to 'I've got it! I could teach someone else'. Any student who selects the option: 'I've got it! I could teach someone else' must provide some evidence that this is the case in the box provided.

The self-assessment rubric has a two-fold benefit; it not only provides us with evidence of genuine or lack of understanding but also allows the students to see a progression of their learning, as the rubric is filled in at both the beginning and the end of the unit. This information is then used to inform our differentiation, planning, and grouping.

This approach we believe is a fundamental component of the revised curriculum, for historically, it has not been unusual for teachers to teach according to a student's year level, however, this curriculum focuses on teaching at each individual student's level; providing truly individual learning outcomes.

At the beginning of each unit students are provided with a task sheet which informs them of the goals and standards they are expected to achieve, and the criteria they will be assessed against. This task sheet helps students reflect on their thinking, to plan their work, to monitor their understanding, and evaluate their progress. The overall goal is to teach students to self-manage and self-monitor their learning. The task sheet allows students to select (with guidance and encouragement from the classroom teacher) from a variety of activities to develop their learning and understanding. Each activity on the task sheet is scaffolded and activities are planned from VELS levels 2 to 6.

Topic tests are standard practice in secondary Mathematics programs; however, from our experience we have noted that it is not unusual for students who are operating at four years below the expected level to achieve 70% or more in a class 'topic' test. The question is then, what are these tests actually testing? To compound the detrimental effect of these tests, when they are reported on these tests are both arbitrary and misleading for parents, who would assume that their children are achieving a better than average score.

The summative information provided by the On-Demand testing of our students, although useful for generating "ball-park" information on our students, it does not provide evidence about which specific learning outcomes have been achieved, therefore additional means of assessment are employed, such as Scaffolding Numeracy testing options; student self-assessment with the Happy Face sheet; diagnostic tests from the Department of Education and Early Childhood Development (DEECD); formative assessment tasks. Our assessment is ongoing and purposeful. Students are regularly encouraged to justify their answers by explaining procedures to peers and with opportunities for assessment by interview.

There have been a number of other aspects of the revised numeracy program which have proved to be beneficial:-

A framework for team teaching;

Opportunities for students to separate into homogenous groups;

Pairing up with a higher skilled peer for problem solving activities.

The revised numeracy program also provides staff with advantageous outcomes:-

- Shared planning, ideas and resources;
- Personal and professional development;
- Joint reflection and moderation of work;
- Mentoring, modelling and coaching.

The benefits of all of the above translate into better quality teaching and ultimately improved student learning (Stephens, 2009).

The implementation of a cross-campus curriculum for the teaching of Mathematics in years 7-10 have achieved the following outcomes:-

- Improved student learning in Mathematics as measured by NAPLAN and On-Demand assessments.
- Improved student engagement (student survey data)
- Consistency within the college regarding the curriculum, its delivery and enhancing transition to senior campus.
- An approach that is consistent with the WMR direction as described in the Blueprint For Schools.
- Preparation for anticipated merger of the three junior campuses.
- Shared planning and preparation thus allowing teachers to work smarter, not harder.
- Whole school analysis of data to inform the planning of effective learning.
- Consistency in report writing.

The Hurdles

As the uptake of the program by college staff is central to our goal of improving whole school data, it was important for us to manage the change process as effectively as possible. Our goal was to “*pursue a successful program of organisational change*” (Sparrow and Knight 2006, pp.xiv) and not just change for the sake of it or change the practice of only a few individuals as this would not have a significant effect on our data. To this end, we felt that we had to:-

1. Convince our staff of the need to change;
2. Show that our program had been tested and refined;
3. Demonstrate that the data collected was impartial and rigorous and not solely anecdotal;
4. Prove that each aspect of the program had a legitimate reason for inclusion and that nothing was changed just for change’s sake; and
5. That we were in it with them, teaching similar students.

To this end we have endeavoured to 'prove' that the changes we proposed to teaching numeracy really work.

Essential components of the whole school numeracy program

Delivery of a fully differentiated curriculum with a team of teachers can only occur if the lessons are planned and delivered with contributions from all members of the team. This ensures that the students receive the best possible learning outcomes. All teachers teaching the unit take ownership of the lessons and ensure that they are fully informed of the expected outcomes for each lesson. Additionally, team planning provides consistency, transparency of practice and accountability. Team planning also provides opportunity for reflection however, it is essential that all involved are provided with an adequate allocation of planning time and can agree on a common set of goals.

Conclusion

Over the past 18 months, On-Demand data has been collected from two populations of students, one that had been taught using the revised whole school numeracy program, the other group taught using traditional teacher centred practices. This data indicated that students taught using the revised whole school numeracy program had improved, on average, by 0.3 VELs during the year (On-Demand General Adaptive Test), whilst the students who have been taught in the traditional manner had registered an average improvement of only 0.1 VELs level per year. This means that whilst our students do not yet attain the state average yearly improvement of 0.5 VELs, they are improving three times more than the students at our school who are not in the program.

This three-fold increase in student achievement was recognised by Monash University audit of the School's Strategic Implementation Plan. They recommended the program be extended to all junior campuses. (Auditor's Report on Sunshine College Strategic Implementation Plan, 2006-2009).

Additionally, the Ardeer Campus Year 9 students are the first students to complete two full years of the Numeracy Program and we anticipate that the 2010 NAPLAN data from these students will be indicative of the efficacy of the program.

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