Counting On 2007: A Program for Middle Years Students who have Experienced Difficulty with Mathematics

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The Counting On 2007 project was designed to support the professional development of teachers in identifying and addressing the learning needs of middle years students in mathematics. It was based on earlier models and included changes designed to simplify and encourage further and ongoing involvement of schools. One change was a simplified assessment process that provoked initial concerns that teachers would not develop an appreciation of their students' specific difficulties nor a deep understanding of the learning framework in number and thus the students' learning would suffer as a consequence. Implemented in 122 schools across NSW, the findings for the program indicated it was successful in assisting students who had struggled with mathematics with 66% of the students increasing their place value understanding by one or more levels and similarly with 65% for multiplication/division, while providing a vehicle for teacher professional learning.

Background

New South Wales is not the only state concerned with students in the middle years who are struggling with mathematics. Gervasoni, Hadden, and Turkenburg (2007) conducted a large study of number learning in 2006 of over 7000 Victorian children in Ballarat for the purpose of identifying issues that could inform the development of a professional learning plan. A notable number of students (31%) beginning Grade 6 were found not yet able to read, write, order, and interpret four-digit numbers nor use reasoning-based strategies for calculations in addition and subtraction, and multiplication and division.

Are teachers and poor teaching to blame? Vaiyatvutjamai and Clements (2004) analysed the errors made by 231 form three (year nine) Thai students in two Chiang Mai government secondary schools. Students completed tasks before and immediately after a series of 13 lessons. A number of misconceptions were revealed and although some were clarified as a result of the lessons, there were others that remained and seemed to be "fossilised". A "fossilised misconception" was used to denote the situation where a student maintains a faulty conception despite having been specifically taught the "official" defining characteristics of the relevant concept. Associated with this then is the absence of cognitive change over time or even resistance to change over time, so that cognitive inertia persists despite the individual having been taught the "proper" view of the concept. The Counting On 2007 project was designed to support the professional development of teachers in identifying and addressing the learning needs of middle years students who are struggling in mathematics, many of whom may possess "fossilised misconceptions".

The research base for the program was provided through the Counting On Numeracy Framework (Thomas, 1999) which made use of work completed by a number of researchers such as Cobb and Wheatley (1988) who conducted research into children's initial understandings of ten; Beishuizen (1993) who researched the mental strategies, materials, and models used by teachers and students in addition and subtraction computations of numbers up to 100 in Dutch second grade classes; Jones, Thornton, Putt, Hill, Mogill, Rich, and van Zoest (1996) who studied multidigit number sense and developed a framework for instruction and assessment; and the Count Me In Too Learning Framework in Number (Wright, 1998; Wright, Martland, & Stafford, 2000).

The Counting On program has been evaluated a number of times, beginning with a pilot study involving nine schools conducted by Mulligan (1999). The Counting On program began in 2000 involving 40 government schools, more than 600 students, 120 school teachers and 40 district mathematics consultants. Further evaluation reports on the Counting On program were conducted in 2000, 2002, and 2003 (Perry & Howard, 2000, 2001a, 2001b, 2001c, 2002a, 2002b, 2003). During 2001, the Counting On program was implemented in 76 primary, four central, and 75 secondary schools across NSW, involving more than 1400 students, 321 school teachers, and 40 district mathematics consultants. During 2002/2003, the Counting On program involved three high schools per district and two feeder primary schools in each of the 40 districts. It was a feature of all the evaluations that Counting On resulted in an improvement in student learning outcomes in computation and place value.

In 2007 there were significant changes made to the program. Counting On 2007 was implemented in 122 schools across the state and was based on the previous models but included changes designed to simplify and encourage further and ongoing implementation by schools. Features of the revised model included: a simplified assessment instrument; the inclusion of Newman's Error Analysis (Newman, 1977, 1983); a revised Counting On CD using an interactive interface that linked the learning framework to video explanations of the framework and snippets of student responses. It also included additional material and learning objects on fractions, decimals, and percentages; school clusters, the formation of which was intended to strengthen a middle school focus; and a facilitated professional development model for the program which was necessary due to a change from district to regional model by the New South Wales Department of Education and Training. It is beyond the scope of this paper to examine all of the changes and so it will focus mainly on the first mentioned change.

Earlier evaluations had reported teacher concerns with time demands and workload resulting from the program, "the issue of time – an almost universal one with Counting On—raised its head again" (Perry & Howard, 2001, p. 43). The simplified assessment instrument meant that teachers were no longer required to administer a 17 item assessment instrument using individual student interviews that were video-taped for later assessment purposes. The new approach used a whole class approach covering place value, addition, subtraction, multiplication, and division tasks. The class teacher then sorted the student responses into one of three groups: apparent expert, intermediate, and a target group. Only the selected students would then complete the additional assessment items involving two of the original assessment items (one on place value and one on multiplication and division) and two questions involving Newman's Error Analysis. This saved considerable time but there were initial concerns that teachers would not develop an intimate appreciation of their students' specific difficulties nor a deep understanding of the learning framework and thus the students' learning would suffer. This paper concentrates upon these concerns and reports on the evaluation of the student learning outcomes for 2007.

Methodology

The sample consisted of selected middle years students (years 5 to 9) chosen from the 122 schools who were grouped into 30 clusters across nine of the ten New South Wales Department of Education and Training regions. The number of clusters that each region could nominate was fixed, based on an analysis of the system wide Secondary Numeracy Assessment Program (SNAP) results. Most clusters contained from three to five schools, although some contained smaller and larger numbers depending on local circumstances. Primary schools, secondary schools, and central schools were involved in the program.

The revised assessment instrument was administered by the class teacher as a whole class schedule covering place value, addition, subtraction, multiplication, and division tasks. The assessment schedule was closely linked to the learning framework and the data were used by the teacher to identify the student target group.

Table 1

Learning Framework Levels of Conceptual Development in Place Value and Multiplication and Division (Perry & Howard, 2001b, p. 412)

Place value		**Multiplication and division**	
Level	Descriptor	Level	Descriptor
0	Ten as count	0	Unable to form equal groups
1	Ten as unit	1	Forming equal groups
2	Tens and ones	2	Perceptual multiples
3	Hundred as unit	3	Figurative units
4	Hundreds, tens, & units	4	Repeated abstract composite units
5	Decimal place value	5	Multiplication and division as operations
6	System place value	6	Not used

From the target group on two occasions, teachers were asked to conduct a target group assessment process with a minimum of five students per class and to record the student data on an Excel spreadsheet supplied to them. The spreadsheet recorded the initial level on the learning framework (see Table 1) for the targeted students before the Counting On 2007 program was implemented and again following 10 weeks of targeted Counting On 2007 activities. This process was similar to other reported evaluations. These results were compiled and are reported in the next section.

Results

A total of 102 schools from the 122 submitted data to the CA, consisting of 71 primary schools, 26 secondary schools, and 5 central schools. There were 1306 students included on the spreadsheet with 940 primary students (72%) and 366 secondary students (28%). The table below lists the students by their year cohort.

Table 2

Student Numbers By Year Cohort

School Year	Frequency	Percentage Frequency
4	40	3.06%
5	488	37.37%
6	412	31.55%
7	269	20.60%
8	70	5.36%
9	11	0.84%
No Year	16*	1.23%
Total	**1306**	**100.00%**

*Note: There were 16 secondary students missing Year details

The spreadsheet was used to record the initial level before the Counting On 2007 program was implemented and again following 10 weeks of targeted counting on activities.

Place Value

Using a paired samples t-test, the 10 week Counting On 2007 program had a significant effect upon student place value learning outcomes ($t=37.143$, $p<0.001$). The difference graph (see Figure 1) shows diagrammatically the changes that occurred as a result of the program. The graph clearly shows that the majority of students improve by 1 level with a sizeable group improving two levels. There are a small group who improve by 3 and 4 levels as there are some who decline by 1 or 2 levels.

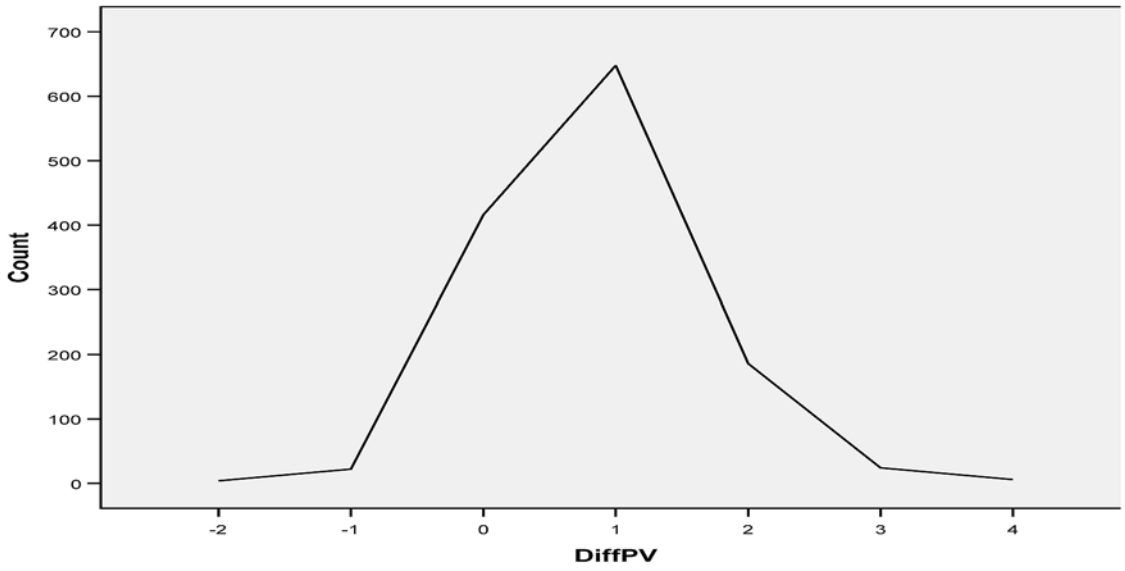

Figure 1. The difference in place value levels.

Multiplication and Division

The results for the students' multiplication and division levels show improvements in student learning outcomes. Using a paired samples t-test, the 10 week Counting On 2007 program had a significant effect upon student multiplication and division learning outcomes ($t=33.754$, $p<0.001$). The difference graph (see Figure 2) shows diagrammatically the changes that occurred as a result of the program. It shows that the majority of students improved by 1 level with the next sizeable group showing no improvement and over 200 students improving two levels.

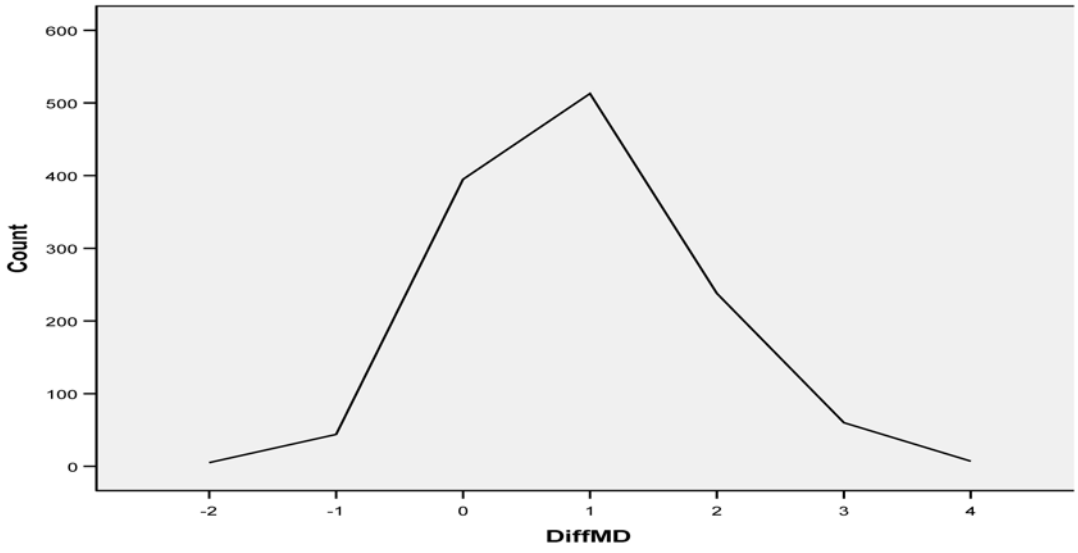

Figure 2. The difference in multiplication and division levels.

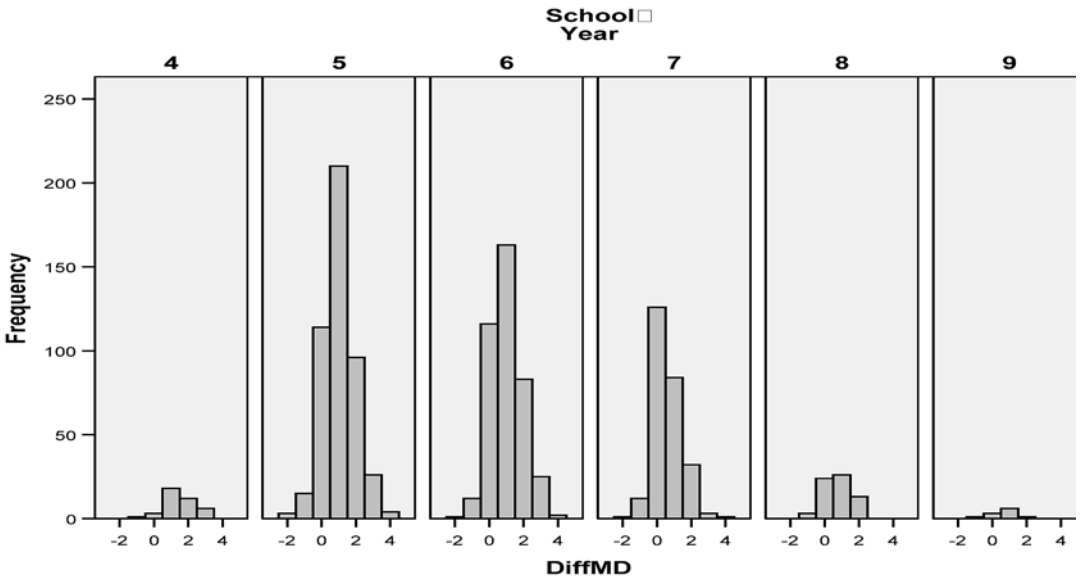

Figure 3. The difference in multiplication and division levels according to student year cohort.

There is a small group of students who improve by three and four levels as there are some who decline by one or two levels. The differences in levels according to student cohort are shown in Figure 3.

Table 3

Frequency Distribution Of Negative Difference Outcomes (Final – Initial Level)

No of negative student outcomes	No of schools	Percentage of Total Negative Difference Outcomes
1	14	18.7
2	4	10.7
3	6	24.0
4	3	16.0
5	3	20.0
6	0	0
7	0	0
8	1	10.7
Total	31	

There were 26 students who received a negative difference outcome (Final level – Initial level) on the place value scale and 49 on the multiplication/division scale. In Table 3, there were 14 schools with only one negative difference outcomes (18.7% of all errors) in their total results, whereas one school accounted for eight (30.7%).

Discussion

In an attempt to reduce the assessment load on teachers a simplified procedure had been adopted. While it saved considerable time, there were concerns that teachers would not develop an intimate appreciation of their students' specific difficulties nor a deep understanding of the learning framework and thus the students' learning would suffer. The results across the Counting On 2007 program indicate an improvement in student learning outcomes by one or more levels in their understanding of place value (66%) and in their understanding of multiplication/division (65%).

However, the concern with teachers understanding of the learning framework is not so easily dismissed. There was an issue regarding the student learning outcomes where some cases indicated the final assessment result was lower than their initial result. There may be a variety of reasons such as the students have done more poorly as a result of the program, that these students were deskilled by the program. Vaiyatvutjamai and Clements (2004) studied students across the range of student abilities, and the results for low performing students challenged the use of the term misconception when associated with many of the errors those students made. "A misconception can be regarded as a fairly stable, but inappropriate, way of thinking ... analysing the errors made by low performers in this study, was that the word 'stable' was not one that could sensibly be used" (p. 181). Students with "unstable" conceptions will give different answers at different times and hence their test scores are not stable and may at times decline.

Another source of possibilities for the decline in some student outcomes could be that teachers became more familiar with the assessment or their students' ability at the time of the final assessment than they were when the initial assessments were made and so the students were not correctly placed initially. An e-survey sought the opinions of regional mathematics consultants (*n=15*) and school program facilitators (*n=40*). Their responses included reasons such as the use of different assessors, poor initial teacher understanding of the learning framework, misdiagnosis, student resistance to assessment, poor student attendance, and transcription errors. Table 3 indicates there were 14 schools with only one negative difference outcomes (18.7% of total) in their results, whereas one school accounted for eight (10.7%). The spread of results suggests a mix of reasons and does not suggest widespread poor initial teacher understanding of the framework.

Conclusion

An important issue for a program such as Counting On which attempts to target students struggling with mathematics in the middle years lies in the difficulty in providing specific assistance for such a group of students without making the task too onerous for the classroom teacher. Previous evaluations of Counting On had highlighted teachers' concerns over time demands and workload. Thus Counting On 2007 sought to adjust the balance by reducing the teachers' load through a number of changes, particularly to the assessment procedure. There was a concern that the adjustments may affect the student learning outcomes and teachers understanding of student difficulties and the learning framework.

This paper has indicated that the adjusted program continued to be successful in assisting the learning of students who had struggled with mathematics in the middle years of school while providing a vehicle for teacher professional learning.

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