A Systemic Program for Students Who Are Experiencing Difficulty with Mathematics as They Transition from Elementary to High School in Australia

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Counting On is a systemic mathematics program that targets low achieving students in the final year of government elementary and the first year of government secondary schools through the professional development of their teachers. During 2000, *Counting On* was implemented in 40 secondary schools, involving more than 600 students, 120 school teachers and 40 district mathematics consultants. In 2001, the implementation was extended to approximately 80 secondary schools and 80 final year elementary classes which 'feed' these secondary schools, involving some 1400 students, 320 teachers and 40 district mathematics consultants. This paper reports on evaluations of the program in 2000 and 2001, with particular reference to students' movement across the levels of conceptual development in place value contained in the numeracy framework which underpins the program.

The New South Wales Department of Education and Training (DET) is the government authority responsible for school education in the state of New South Wales, Australia. As such, it runs some 2000 elementary schools (students aged approximately 5 to 12 years) and 400 secondary schools (students aged approximately 12 to 18 years) as well as a small number of preschools and many technical and further education institutions. *Counting On* is a DET mathematics program that targets low achieving students in the first year of secondary (Year 7) and the last year of elementary schooling (Year 6). Hence, the students involved range from 11 to 13 years of age. In both 2000 and 2001, the authors of this paper undertook evaluations of *Counting On*. It is from these evaluations that the data for this paper are drawn. Earlier papers (Perry & Howard; 2001a, b) have explored the 2000 data on its own but this is the first paper to consider both years.

Background

The rationale and structure for the *Counting On* program are outlined in the following extracts from the program documentation:

> Too many students enter secondary school with calculating methods that consist solely of schemes of counting by one. While these methods will often result in the correct answer, they take so much effort that there is little chance of learning new material. The learning of these students in mathematics has reached a plateau. (NSW Department of Education and Training, 2002, p. 5)

> The intent of *Counting On* is to build the professional knowledge of the teachers involved in the project. Furthermore, it aims to assist teachers in addressing the learning needs of students who are not demonstrating progress … (NSW Department of Education and Training, 2002, p. 7)

The link between professional development and student learning outcomes is well established (Cook & Fine, 1997; Dockett, Perry, & Parker, 1998). The aim of teacher professional development is to produce change in teacher knowledge and teacher practice and, through these, change in student outcomes. Effective professional development

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"establishes new expectations for students, teachers, and school communities" (Cook & Fine, 1997, p.1).

Counting On operates through a team of teachers from each secondary school and its feeder elementary schools. Each team consists of:

- the head teacher, mathematics; Year 7 classroom mathematics teacher(s) and the support teacher learning difficulties in the secondary school;
- Year 6 classroom teacher(s) from the elementary school(s); and
- the district mathematics consultant.

The theoretical foundation for *Counting On* is the *Learning Framework* (Mulligan & Mitchelmore, 1996; NSW Department of Education and Training, 2002; Thomas, 1999; Wright, Martland, & Stafford, 2000). This framework provides a structure of levels of conceptual development in place value and in multiplication and division. The place value framework relevant to this paper is provided in Table 1, along with a brief explanation of each level.

Table 1
Learning Framework Levels of Conceptual Development in Place Value

Level	Descriptor	Explanation
0	Ten as count	Student can count on but uses single units.
1	Ten as unit	Student treats ten as a single unit, made up of ten ones.
2	Tens and ones	Student solves addition and subtraction without representations of tens and ones being available. Ten is treated either as an iterable or abstract collectible unit.
3	Hundreds, tens, & ones	Student can use hundreds, tens and ones for standard decomposition of three-digit numbers and can mentally add and subtract combinations of numbers to 1000.
4	Decimal place value	Student uses tenths and hundredths with understanding of positional value.
5	System place value	Student knows that place value system can be extended in two directions.

Methodology

The evaluation of the *Counting On* program employed intensive case studies on four of the sites, pre- and post-test implementation of the student assessment schedule and team surveys. This paper concentrates on the data arising from the pre- and post-test student assessment data and uses some explanatory comments from the case studies.

A key feature of the *Counting On* program is an intensive assessment interview which is undertaken individually by each student before the teaching program begins and shortly after the teaching program has been completed. All assessment interviews were conducted by a member of the *Counting On* team on each site and were video-recorded for later analysis by the whole team. In 2000, the assessment schedule consisted of 19 questions covering place value, addition, subtraction, multiplication and division tasks. In 2001, the number of questions was reduced to 17 with the same coverage of topics. Many, but not all, of the 2001 questions were also part of the 2000 assessment schedule. A copy of the assessment record for each student completing the interview was made available to the authors for the two assessment implementations in both 2001 and 2002.

The assessment record for each student provided data on whether or not the student made a valid attempt at each question, whether the answer given was correct or incorrect and which strategies were used to answer the question. As well, the overall levels on both place value and multiplication and division at which the *Counting On* team deemed the student to be working—following a group analysis of the videotaped recording—were recorded.

In 2000, results from 671 Year 7 students were received for the first student assessment (2000,T1) with the results from 544 of this Year 7 cohort being received for the second assessment (2000,T2). The gender breakdown of these two cohorts was 2000,T1: 63.2% male, 36.8% female and 2000,T2: 62.5% male, 37.5% female.

In 2001, at least partial data were received from 1416 students from both Year 6 (30.3%) and Year 7 (69.7%). Of the total number of these students, 56.9% were male and 43.1% female. The gender mix for the Year 6 students was 53.8% male and 46.2% female while, for the Year 7 students, it was 58.3% male and 41.7% female. Almost all of the 1416 students for whom there are partial data (1404) undertook the first assessment (2001, T1) but only 1176 undertook the second assessment (2001, T2).

The decrease in numbers between the two assessments in both 2000 and 2001 can be ascribed to students leaving the schools, selecting not to continue with the program, being unwilling to be videotaped a second time and being absent from school on the second assessment day, along with the fact that the second assessment results were not received from a few of the schools.

Results

For this paper, only the data concerned with the overall place value levels for each student will be considered. In each of 2000 and 2001, each student was assigned a place value level (from 0 to 3 only as only whole number place value was assessed) from each of the pre- and post-assessment interviews. Tables 2 - 4 show the distribution of these levels for each year.

Table 2
Percentages of Year 7 Students in Each Place Value Level—2000, T1 and 2000, T2

Level 0		Level 1		Level 2		Level 3	
T1	T2	T1	T2	T1	T2	T1	T2
31	8	36	36	24	30	10	26

Table 3
Percentages of Year 7 Students in Each Place Value Level—2001, T1 and 2001, T2

Level 0		Level 1		Level 2		Level 3	
T1	T2	T1	T2	T1	T2	T1	T2
35	13	35	31	23	40	7	16

Table 4
Percentages of Year 6 Students in Each Place Value Level—2001, T1 and 2001, T2

Level 0		Level 1		Level 2		Level 3	
T1	T2	T1	T2	T1	T2	T1	T2
42	15	37	30	20	43	1	12

Discussion

These data show that, in both 2000 and 2001, there have been overall increases in place value levels for all groups of students as they have moved through the *Counting On* program. It is not possible to ascribe these increases to the program without a control group with which to compare. Such a control group was not available to the researchers. However, comparisons can be made between the two Year 7 groups from 2000 and 2001 and between the Year 6 and Year 7 groups in 2001. Figures 1 – 3 show clear increases in the place value levels for all three of the cohorts described above.

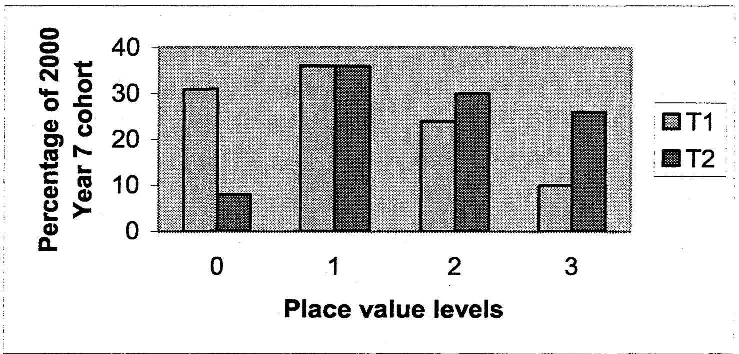

Figure 1. Percentage of 2000 Year 7 students in each place value level for 2000, T1 and 2000, T2.

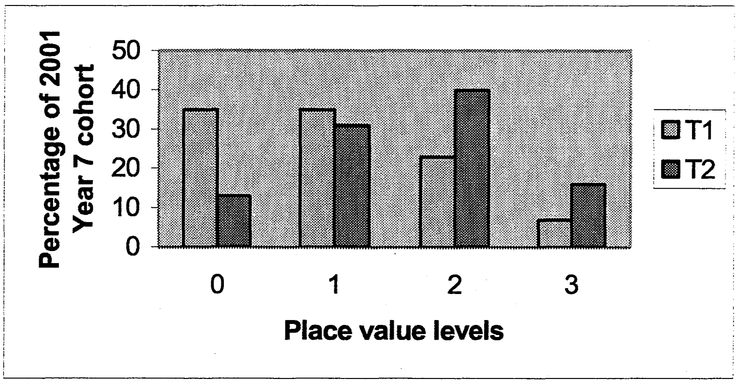

Figure 2. Percentage of 2001 Year 7 students in each place value level for 2001, T1 and 2001, T2

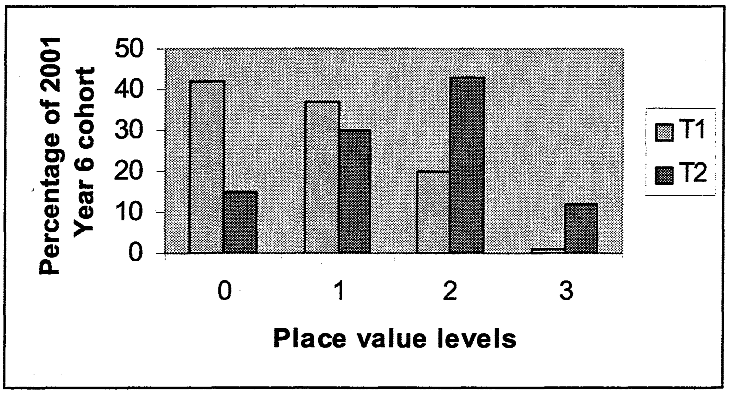

Figure 3. Percentage of 2001 Year 6 students in each place value level for 2001, T1 and 2001, T2

Two-way contingency table analyses showed that the changes in individuals' place value levels from T1 to T2 were highly significant for Year 7 in 2000 (χ^2=173.51, p<0.001) and each of the Year 6 and Year 7 cohorts in 2001 (Year 6: χ^2=190.96, p<0.001; Year 7: χ^2=590.86, p<0.001). In every case the differences were significant for both male and female students.

For the 2001 cohorts, Mann-Whitney U tests were conducted to evaluate the hypothesis that Year 6 and Year 7 students would score equally, on the average, on place value levels in T1 and T2. The results of the test were significant for T1, z=-4.11, p<0.001, with Year 7 students, on average, scoring higher than Year 6 students, but were not significant for T2. These results indicate that *Counting On* does seem to have had a differential effect on students in Year 6 and Year 7, with Year 6 substantially 'catching up' to the Year 7 cohort.

Further analysis can track individual growth across the place value levels achieved in each of T1 and T2. Table 5 and Figure 4 show the results of this tracking for each of the cohorts: 2000, Year 7; 2001, Year 7 and 2001, Year 6. In each case, small percentages of students have been recorded at a lower final place value level. This could be due to an incomplete understanding of the assessment process by the *Counting On* teams or a result of lack of attendance or illness on the part of the students or even transcription errors when recording the data. It is also possible that these students did not understand the task or the process. However, the overriding feature is the large percentage of students in all the cohorts who have maintained their level or have increased their place value assessment by at least one level, with more than 14% of the 2000, Year 7 cohort, almost 11% of the 2001, Year 7 cohort and more than 12% of the 2001, Year 6 cohort increasing by at least 2 levels. The graph in Figure 4 clearly shows that a greater proportion of the 2001, Year 6 students than either the 2000, Year 7 or the 2001, Year 7 students has increased one or two levels in their place value performance while greater proportions of each Year 7 cohort than the Year 6 group have decreased by one or two levels in their place value performance.

Table 5
Percentages of each assessment cohort and their growth in place value levels (missing data disregarded)

Growth in place value levels	-3	-2	-1	0	1	2	3
2000, Year 7	0.2	1.2	7.5	39.6	37.4	11.5	2.6
2001, Year 7	0.0	0.1	3.5	48.7	36.9	10.2	0.6
2001, Year 6	0.0	0.0	1.6	40.6	45.1	12.2	0.5

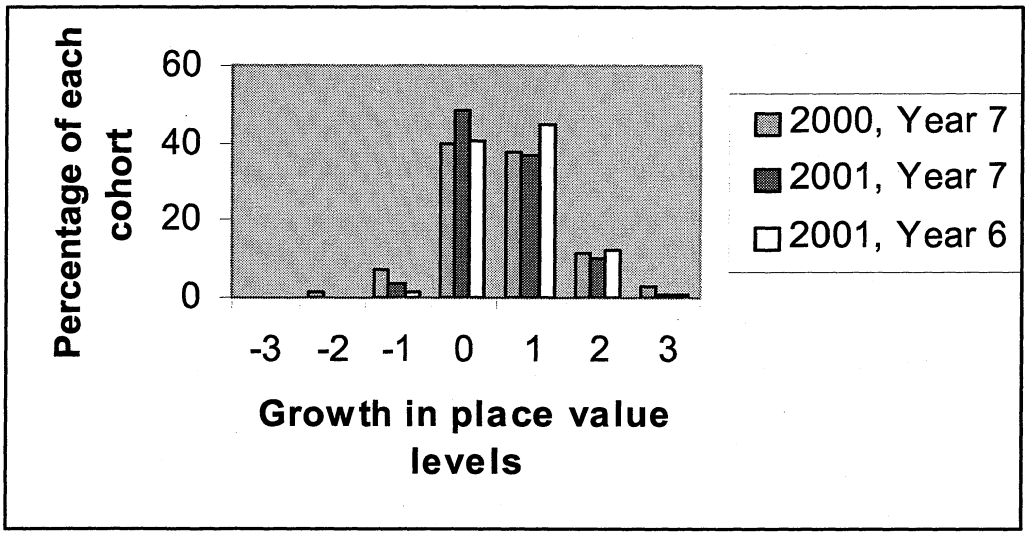

Figure 4. Growth in place value levels from T1 to T2 for 2000, Year 7; 2001, Year 7 and 2001, Year 6 cohorts.

The analysis shows that there are significant increases in the place value levels shown by the students in each of the cohorts as they move from T1 to T2. That is, the students are moving upwards through the learning framework. For all of the cohorts, there are statistically significant gender differences in the performances on each of the two assessment interviews but there are no statistically significant gender differences in the growth in place value levels in any of the three cohorts. That is, both boys and girls start at different points, finish at different points but their growth across the program is similar. This suggests that the *Counting On* program does not act differentially on either group.

Another interesting finding from this analysis is the 'catching up' phenomenon where the Year 6 students in 2001 seemed—as a group—to make up, by the time of the implementation of T2, a lot of the difference between themselves and the 2001, Year 7 group which was shown in T1. This suggests that the *Counting On* program is suitable for application in Year 6 and that, in fact, Year 6 may be a more suitable time than Year 7 for initial implementation of the program. Further investigation of this proposition needs to be undertaken.

Conclusion

> "The *Counting On* project concentrates on those aspects of the [learning] framework necessary to assist the movement of students from unitary to composite-based mental strategies." (NSW Department of Education and Training, 2002, p. 15)

Given that higher levels of the learning framework reflect more composite-based strategies for place value, the *Counting On* program in 2000 and 2001 has achieved this aim. With a relatively short period of intervention and focussed teaching activities, the students have generally advanced on the learning framework, as assessed in the pre- and post-tests. The increases in levels are statistically significant and pedagogically important.

Some idea of the importance of *Counting On* to the development of mathematical learning and teaching in the primary and secondary schools of NSW can be gleaned from comments of teachers in the four case studies undertaken by the authors as part of the overall evaluation.

In one of primary schools, the classroom teacher believed that he could isolate one feature of *Counting On* which stimulated substantial learning of mathematics. He illustrated it through a description of the progress of his most outstanding *Counting On* student.

> I was quite amazed by one of the kid's grades. I think that the thing that really suited him was the very explicit nature of the teaching and the fact that it built core numeracy skills which, for whatever reason, he hadn't obtained in his previous schooling. ... There is a real pattern kind of thing built into *Counting On*. Kids see patterns. That really helped him. It helped all of them.

This impression was reinforced by the one of the secondary classroom teachers:

> Traditionally you would teach kids maths in a certain way to make sure that the answer is correct and there was always a standard procedure and now I do something in a classroom like counting up from 7 in 10s and we do it differently. I just find it a newer teaching and I think a lot of kids like it and will benefit from that. I think that most people know that is the thing to do. We have never been taught how to do it.

Similarly, another primary classroom teacher emphasised the importance of teachers and students thinking about their mathematics teaching and learning.

> It re-focuses teaching to the extent of ... thinking to yourself, 'Hang on, this also has to do with place value and if they don't understand the place value then they are not going to...They might remember to put the zero in but you are guaranteed to come unstuck'. It really makes you think what the purpose of a lesson is and gets the kids tuned in and focused. You think what your next step is—building in reminders for them.

The importance of being able to interact with students in a small group all focussed on one activity and with one aim was emphasised by a secondary school support teacher.

> The nature of the success is in the interaction. Some kids have a lot of trouble but when they have interaction they have success. ... We can bring them into an environment where they are just a small group and they have access to the board and they get lots of teacher attention. In a small group of six kids the number of interactions that a teacher can have with a child is multiplied.

The quantitative results on changes in the learning framework levels and the anecdotal comments of students and teachers in the case study schools suggest strongly that *Counting On* has been very successful in its aim to help the targeted students to improve their application of mathematical thinking strategies in the area of place value. The expansion of the program into Year 6 classes in 2001 seems to have been successful, both in terms of student assessment results and teacher interactions. Primary and secondary mathematics teachers get very little opportunity to interact professionally. *Counting On* has the potential to encourage that to happen through the opportunity provided by the program for collegial discussions and professional discourse.

One of the interesting opportunities provided by the *Counting On* program as it is currently being implemented is to provide a real link in the mathematics learning of students as they make the transition from primary to secondary schools. The results discussed in this paper show that *Counting On* is an appropriate program for both Year 6 and Year 7 students. It could provide a familiar base for those students who have struggled with mathematics as they commence their high school careers.

The success of *Counting On* highlights the importance of:

- the use of individual video-taped interviews for the assessment of students' mathematical knowledge;
- an emphasis on student strategies as well as outcomes as a way of improving these outcomes;
- small group work in mathematics;
- collegial support amongst teachers, particularly as the students move between schools; and,
- using teaching strategies to change student and teacher beliefs about the learning and teaching of mathematics.

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