# *Counting On:* A Systemic Program for Year 7 Students Who Have Experienced Difficulty with Mathematics

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*Counting On* is a NSW mathematics program for first year high school (Year 7) students who have not achieved Stage 3 outcomes when they commence high school. In 2000 it was implemented in 40 schools and the authors conducted an evaluation of the program. This paper briefly describes the program and considers certain aspects of the evaluation, particularly in terms of the changes in students' conceptual levels in the areas of place value and multiplication and division.

*Counting On* is a systemic program that targets low achieving students in the first year of NSW government secondary school mathematics classrooms. During 2000, *Counting On* was implemented in 40 secondary schools across NSW, involving more than 600 students, 120 school teachers and 40 district mathematics consultants. An evaluation of this implementation was carried out by the authors of this paper.

This evaluation focussed on the following aspects of the program:

- analysis and interpretation of pre-test and post-test data of all the students;
- professional development of teachers in understanding and responding to the learning needs of low achieving Year 7 students;
- implementation and impact of specific teaching activities to support student learning outcomes; and
- consideration of a longitudinal study to track student achievement.

In this paper, we concentrate on the first of these foci and, in particular, on one measure of progress by the students.

## Background

The *Counting On* program focuses on the professional development of teachers in identifying and addressing the student's learning needs and relies on the notion that improved teacher knowledge will result in improve student learning outcomes. It operates on a team approach involving, in each school, the Head Teacher, Mathematics, the Year 7 Classroom Teacher, the Support Teacher Learning Difficulties and the District Mathematics Consultant.

The research base for the program is provided through the *Counting On* Numeracy Framework (Thomas, 1999) which is an extension of work by Cobb and Wheatley (1988) and Jones et al. (1996) and relates to the *Count Me In Too* Learning Framework in Number (Wright, 1998; Wright, Martland, & Stafford, 2000). Details of the program are available in the *Counting On* program Handbook (NSW Department of Education and Training, 2000).

Key elements of the program include the following.

- The training and development of the school teams, both in terms of the teaching activities in the program and the implementation and analysis of the results of the assessment schedule.

- The provision of relief days to each participating school to support the assessment and analysis phases and to encourage discussion among the team members.
- The implementation of a range of teaching activities to meet the varied needs of the selected students.

Students were selected to participate in *Counting On* on the basis of their mathematical achievements but were free to choose whether or not they would join the program.

## Methodology

The *Counting On* evaluation reported here expands on the evaluation of the pilot program which was undertaken in 1999 (Mulligan, 1999). The following data collection techniques were employed in the overall evaluation of the program:

- intensive case studies in four of the schools (see Perry & Howard (2001) for an introduction to the findings of these case studies);
- pre- and post-test implementation of a purpose-written student assessment schedule (that is, application of the assessment schedule before and after the program of teaching activities had been implemented); and
- student and team surveys concerning program satisfaction and improvement.

This paper concentrates on the data arising from the pre- and post-test student assessment data.

On two occasions, each student involved in *Counting On* was assessed using an individually administered schedule consisting of 19 questions covering place value, addition, subtraction, multiplication, and division tasks. This is a refinement of the schedule used in the initial pilot of *Counting On* in 1999 and is closely linked to the numeracy framework. All assessment interviews were conducted by a member of the school's *Counting On* team and were videorecorded for later analysis by the whole team. The results of this analysis were recorded on specially developed sheets. Assessment interviews were scheduled in all 40 schools for Weeks 9 and 10 of Term 1 and Weeks 4 and 5 of Term 3, although sometimes this varied a little.

Results from 671 students were received for the first student assessment (T1) with the results from 544 of these being received for the second assessment (T2). The decrease in numbers between the two assessments 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 one school. The gender breakdown of these two cohorts was T1: 63.2% male, 36.8% female and T2: 62.5% male, 37.5% female.

For each student on each of the 19 questions, the *Counting On* teams ascribed a level of student response based on the strategy used by the student. Following the analysis of each question for each student, an overall level derived from the learning framework was given by the team for place value, and multiplication and division. This was done through discussion and debate in each team, usually led by the Head Teacher, Mathematics, and/or the District Mathematics Consultant. Hence, for the 544 students who completed both T1 and T2, this resulted in two levels for place value, and two for multiplication and division. These levels refer to the levels of the learning framework which are shown in Table 1. They reflect the types of strategies used by students to solve problems in each of these areas. For further details of these framework levels see Mulligan and Mitchelmore (1996), NSW Department of Education and Training (2000), and Wright, et al. (2000).

Table 1
*Learning Framework Levels of Conceptual Development in Place Value and Multiplication and Division*

| 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, & ones | 4 | Repeated abstract composite units |
| 5 | Decimal place value | 5 | Multiplication and division as operations |
| 6 | System place value | 6 | Not used |

## Results

In T1 and T2, each student was assigned a place value level (from 0 to 4 only as only whole number place value was assessed) and a level for multiplication and division (from 0 to 5). Tables 2 and 3 show the distribution of these levels for each of T1 and T2, while Figures 1 and 2 provide a graphical representation of these distributions.

Table 2
*Percentages of Students in Each Place Value Level—T1 and T2*

| Level 0 | | Level 1 | | Level 2 | | Level 3 | | Level 4 | |
|---|---|---|---|---|---|---|---|---|---|
| T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 |
| 31 | 8 | 36 | 36 | 24 | 30 | 9 | 22 | 1 | 4 |

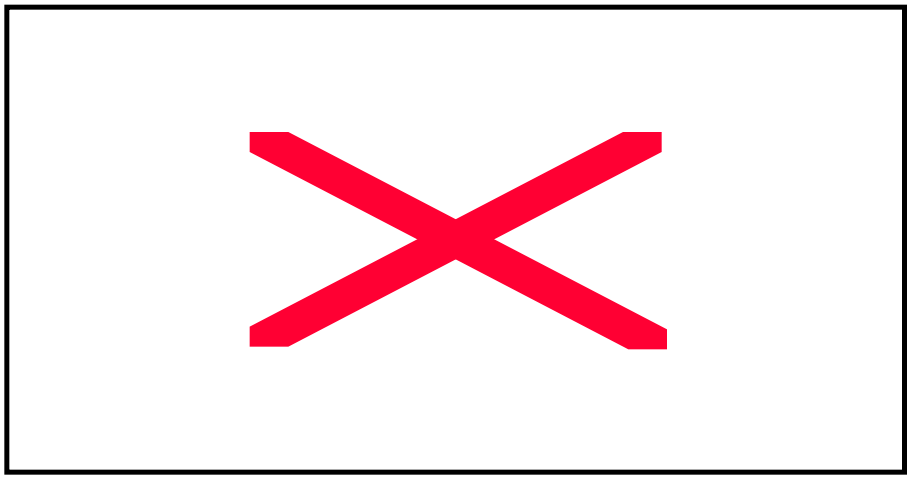

*Figure 1*. Percentage of students in each place value level—T1 and T2.

Table 3
*Percentages of Students in Each Multiplication / Division Level—T1 and T2*

| Level 0 | | Level 1 | | Level 2 | | Level 3 | | Level 4 | | Level 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 | T1 | T2 |
| 2 | 0 | 11 | 5 | 24 | 14 | 26 | 28 | 16 | 21 | 21 | 32 |

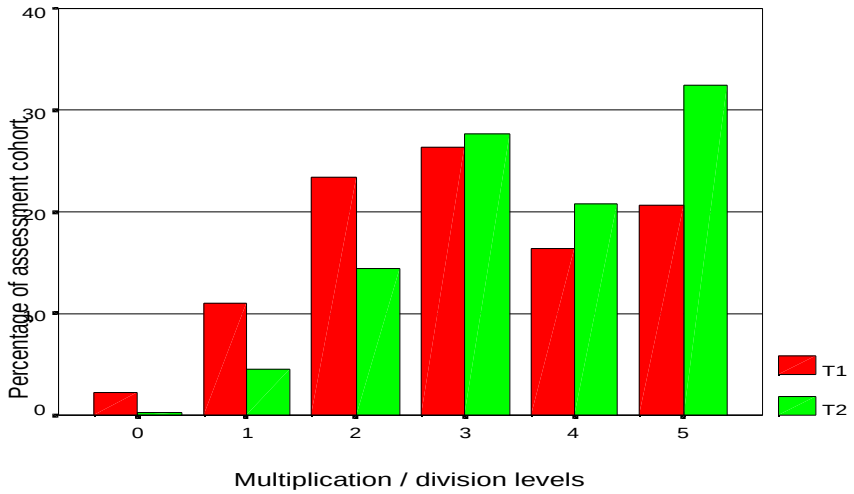


*Figure 2*. Percentage of students in each multiplication / division level—T1 and T2.

## Discussion

Clearly, these data show that there has been an overall increase in both the place value and the multiplication and division levels associated with the students from T1 to T2. We shall discuss each of these separately.

### *Place Value Levels*

Table 2 and Figure 1 show clearly that there has been an overall increase in the place value levels with, for example, 31% of the cohort being at Level 0 in T1 and only 8% in T2, while only 9% of the cohort was at Level 3 in T1 and 22% in T2. Another way to look at this is to note that the mean level score for T1 is 1.17 while, for T2, the mean has grown to 1.78. Further analysis can track individual growth across these levels. Figure 3 shows the difference between the level ascribed for each student in T1 and the corresponding level in T2. Small percentages of students have fallen back in terms of their place value levels and many have remained at the same level. However, the overriding feature is the large percentage increase of at least one level, with more than 15% increasing by at least 2 levels.

A paired sample t-test showed that the increases in level were highly significant for the overall cohort ($t=13.96$, $p<0.001$). When the genders were separated, the results remained highly significant (males: $t=11.41$, $p<0.001$; females: $t=7.90$, $p<0.001$).

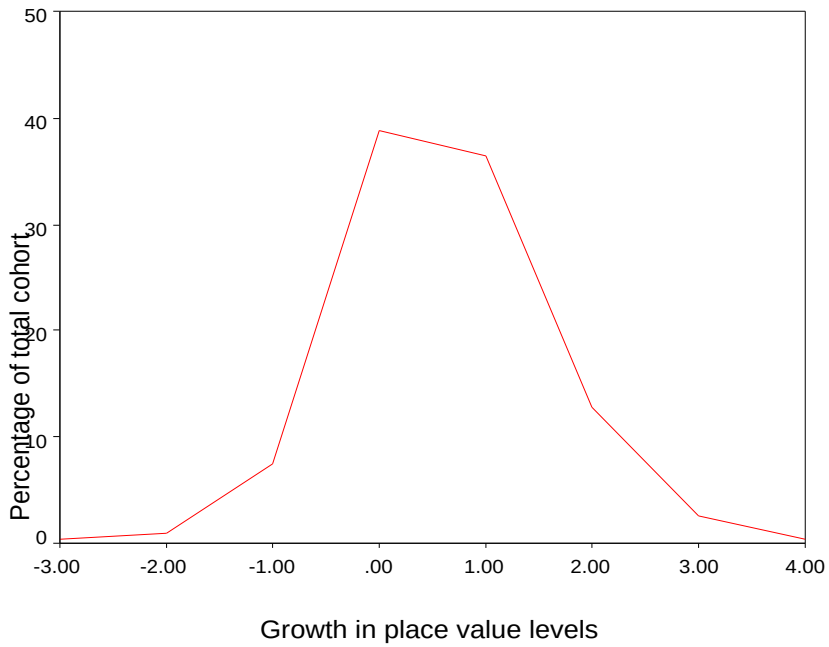


*Figure 3*. Difference graph showing growth in place value levels from T1 to T2.

Using an independent samples t-test, the T1 and T2 place value levels were compared for males and females. It was found that, on both tests, males (T1 mean=1.29, T2 mean=1.93) scored higher than females (T1 mean=0.91, T2 mean=1.50) and that these differences were statistically significant (T1: $t=4.94$, $p<0.001$, T2: $t=4.72$, $p<0.001$). A further analysis of variance on the T2 place value levels across gender with the T1 place value levels as a covariate confirmed the significance of the differences at T2 ($F=9.12$, $p<0.005$). Hence, there does seem to be a differential effect of the program for the place value levels across the gender variable. This is illustrated by Figure 4.

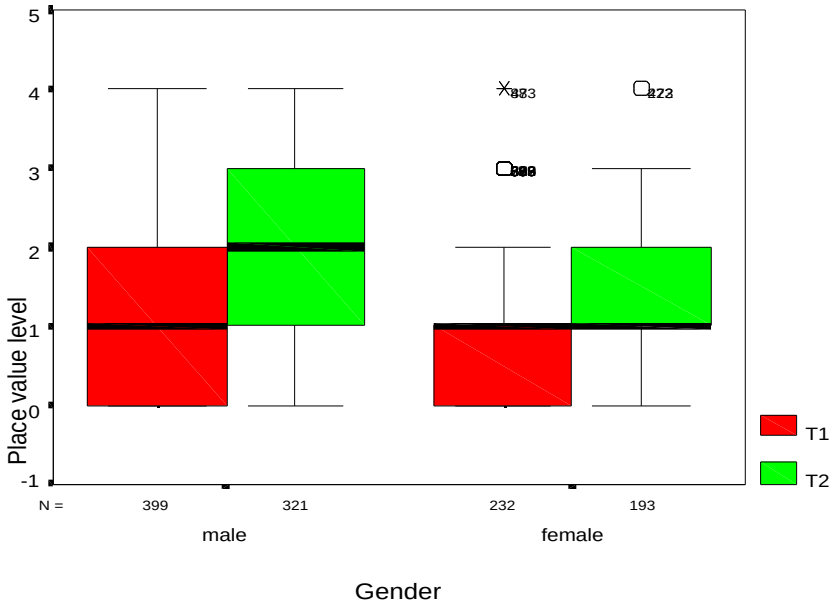


*Figure 4*. Box plot showing differences in place value levels across gender for tests T1 and T2.

### *Multiplication / Division Levels*

Levels for the multiplication / division area in T1 were generally higher than those for place value. Nonetheless, there was a general increase in multiplication / division levels from T1 to T2. This can be seen clearly in Table 3 and Figure 2 above. For example, 24% of the T1 cohort were at Level 2 while only 14% of the T2 cohort were at this level and 21% of the T1 cohort were at Level 5 but this was increased to 32% in T2. The mean level scores rose from 3.10 in T1 to 3.60 in T2. Figure 5 shows the results of tracking individual growth across these levels. Clearly, small percentages of students have fallen back in terms of their multiplication / division levels. However, there is a large percentage of students who have maintained their level and a substantial proportion who have lifted their performance by at least one level.

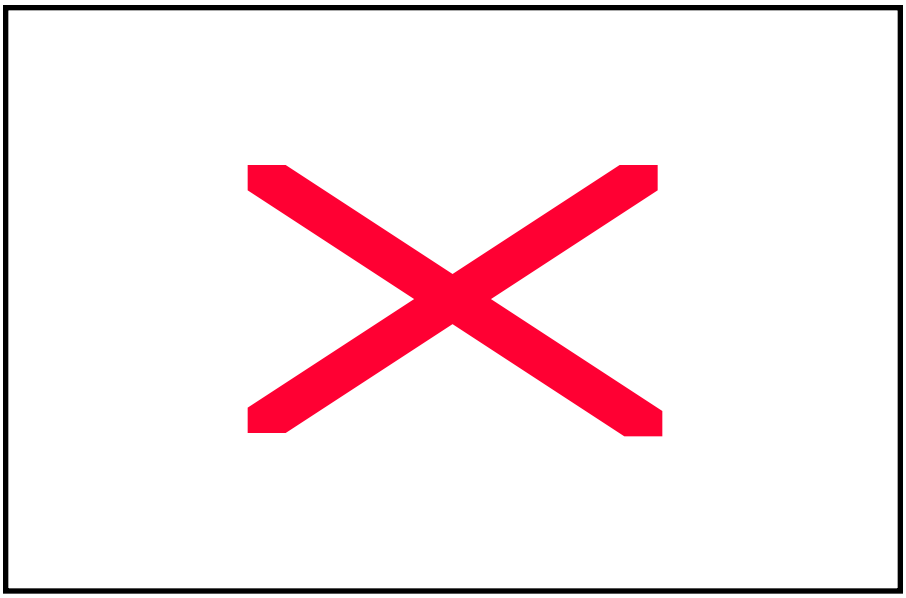

*Figure 5*. Difference graph showing growth in multiplication / division levels from T1 to T2.

A paired sample t-test showed that the increases in level were highly significant for the overall cohort ($t=9.72$, $p<0.001$). When the genders were separated, the results remained highly significant (males: $t=7.67$, $p<0.001$; females: $t=5.79$, $p<0.001$).

Using an independent samples t-test, the T1 and T2 multiplication / division levels were compared for males and females. It was found that, on both tests, males (T1 mean=3.14, T2 mean=3.66) scored higher than females (T1 mean=2.93, T2 mean=3.48) but that these differences were not statistically significant (T1: $t=1.82$, T2: $t=1.70$). A further analysis of variance on the T2 multiplication / division levels across gender with the T1 multiplication / division levels as a covariate confirmed this lack of significance of the differences at T2 ($F=0.50$). Hence, from a statistical point of view, the male and female cohorts are similar on both T1 and T2 and the *Counting On* program seems to have had little effect on this relationship. This is illustrated by Figure 6.

In summary, then, the analysis shows that there are significant increases in the levels shown by the students from T1 to T2 for both place value and multiplication / division. For place value, there are significant differences between genders, with males clearly outperforming females. For multiplication / division, these gender differences do not

appear, even though the males do outperform the girls on average. A question which remains open is why the male cohort seems to outperform the female cohort, even though there are almost twice as many males than females identified as needing the *Counting On* program. One suggestion put forward by the Head Teacher, Mathematics at one of the case study schools was that some male students may be identified as needing the program on grounds which have little to do with their mathematical abilities—such as behaviour—while it is more likely that females would be in the program because of their genuine difficulties with the subject. Further investigation would be needed to determine whether or not this is a plausible reason.

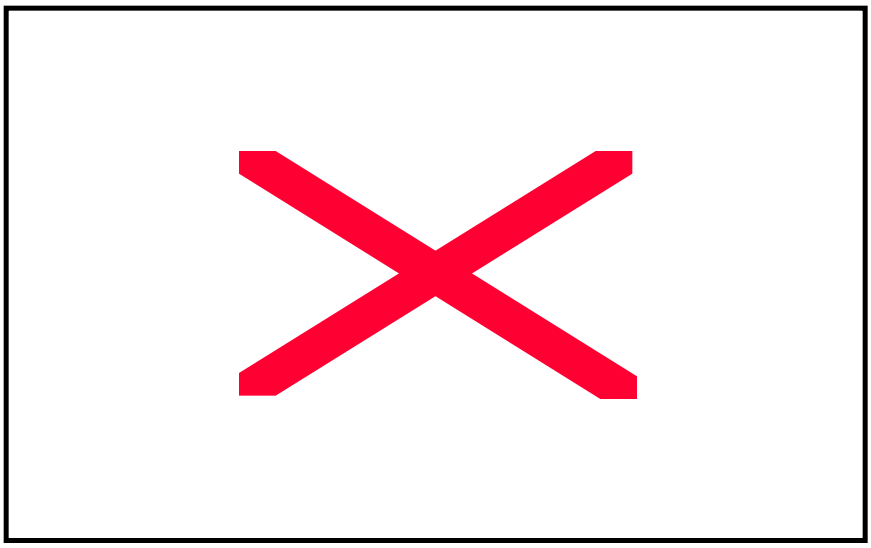

*Figure 6*. Box plot showing differences in multiplication / division levels across gender for tests T1 and T2.

## Conclusion

One of the key aims of the *Counting On* program is "to assist the movement of students from unitary to composite-based mental strategies, specifically, on building the four operations and place value through grouping" (NSW Department of Education and Training, 2000, *The learning framework*, p. 1). Given that such distinctions between strategies are contained in the varying levels of the learning framework in place value and multiplication and division, with higher levels reflecting more composite-based strategies, it would appear that the *Counting On* program in 2000 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. For the first time in many years, students were beginning to enjoy their mathematics as they found some level of success. Comments such as: "I now think I know what I am doing", "I feel much better now about mathematics", "I have a way of thinking about these problems now", and "I am willing to have a go more than I used to be" were typical from students in the case study schools. In one of these schools, the mathematics teacher in the *Counting On* team noted the students development in the following words:

> What it [the program] has done is give them the strategies for the basic skills. When I am using decimals and multiplication the students are able to understand what is happening because they have an understanding of place value and they have an understanding of how to use the basic skills associated with them.

This impression was reinforced by the Support Teacher:

> Overall I think it's gone extremely well. The kids—you can tell that they have learned something over the time. The things that were being assessed at the end—the majority of them went from stage one or below up to, I think the average was, about stage 4 but some of them went to stage 5 in multiplication and division. There were massive differences from the beginning to now and you can see that in the classroom. They are still using those strategies even though we've stopped teaching that way. We still encourage them to use those strategies.

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 areas of place value and multiplication and division. The program has been expanded in 2001, not only in terms of more schools, but also into Year 6—the final year of primary school—in an effort to help students struggling to reach Stage 3 outcomes before they commence high school. *Counting On* is a program which seems to work and its expanded implementation is welcomed.

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