# MASTERING BASIC FACTS? I DON'T NEED TO LEARN THEM BECAUSE I CAN WORK THEM OUT!

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Knowing basic facts is critical for expediency in computational mathematics. By the time students reach the age of eleven some teachers are finding that groups of students are still counting with their fingers or resorting to the use of calculators, tricks with fingers, charts, or asking someone the answers to times tables. The question to be answered is why, after all the years at school, that students cannot remember 55 simple facts? An intermediate school in New Zealand has been investigating ways to motivate the students' learning of basic facts. This paper explores the improvement of student achievement through an action research plan.

## Introduction

Carr and Kemmis' action research model (1986) is well known in education communities and there is a plethora of papers to confirm its use. Often individual teachers will be involved with an outside researcher in a project that encompasses action research but less frequently they are involved in their own school collaborative action research process. Carr and Kemmis define action research as:

> … simply a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out (p. 162).

It is essentially a spiral model involving four steps: planning, acting, observing, and reflecting. As a process to improve teachers' practice, it has many benefits but most importantly it happens in the classroom. This paper focuses on the work of teachers of a school in Dunedin, New Zealand and follows their journey as they ascertain a problem common to all, plan, implement, make observations, and reflect on their outcomes. Within this context it must be clear that this is not the result of an outside researcher's work. The story is the school's one although they are referred to as 'they', 'the staff', or 'the school'.

### Background

Educational settings for students aged 5 to 13 in urban New Zealand are generally primary and intermediate schools. The intermediate school concerned in this paper has 15 teachers and 485 students aged from 11–13 years who vary in academic, behavioural, and social backgrounds. Previously, classes were streamed for mathematics according to students' ability. However, the school has undertaken significant changes in their mathematics programme due to the New Zealand *Numeracy Development Project* (NDP). A mathematics extension programme caters for a small number of students who are working at Level 5 in the New Zealand Curriculum but, in the main, students are no longer streamed and individual differences and needs are catered for within the students' own classes. Since the completion of the numeracy project they have continued to sustain and enhance the changes they have made.

Today visitors can walk through classes in the school and see an environment for mathematics learning. Of note is the mathematics discourse: teachers' questioning that extends students' thinking and shared ideas about problems solved; modelling books that record students' responses; and the use of equipment by students to demonstrate understanding. These are some of the aspects that less than a decade ago would not have been seen in an intermediate school. Teachers within the school are well supported by their principal and deputy principal with school-wide data discussed, targets set, and further development in understanding of the New Zealand Curriculum and the *New Zealand Framework* (Ministry of Education of New Zealand, 2007).

A major part of the professional development in which teachers participated was to focus on how students develop strategies. As numeracy facilitators focused their energies on improving the teaching of strategies it seemed less importance was placed on the teaching of number knowledge and basic facts (found in NDP, Book 1). The school responded to this in 2008 by revising its mathematics programme and explicitly stating that the interdependence of number knowledge and the teaching of strategies should go hand in hand. Strategies create new knowledge through use and knowledge provides the foundation for strategies.

Since then Johnston, Thomas, and Ward (2010) have provided evidence that points to the importance of strategy development but acquiesce that the importance of knowledge should not be underestimated because strategies require knowledge as a pre-requisite for their effective use. This position sat comfortably with the school as staff had explicitly stated they needed to ensure students' knowledge as a prerequisite to introducing new strategy teaching. For example, it did not make sense to offer problems that involved partitioning fractions if the students had little or no knowledge of place value or fractions.

Research has shown that the transition from primary to the intermediate school can show a dip in achievement (Young-Loveridge, 2007). It could be argued that it is perfectly understandable when about 485 pre-adolescent students are feeling, some for the first time, anxious about their learning. Teachers in Intermediate Schools have to work extremely hard to create a positive learning environment for pupils who will be with them for only two years. In an endeavour to create a more harmonious and cohesive teaching unit within their school, the staff turned to action research with the intention of informing and changing aspects of their practice for the improvement of children's achievements.

Previous to 2009 some of the staff had been involved independently in an action research model. However, it was felt that raising achievement of all students demanded a coherent, collaborative process from the whole school staff. Whilst many problematic issues were raised, written up on a board for a couple of weeks and discussed at length, it was decided it would be best to start with a simple question. Observations by teachers in classrooms identified a common problem in lack of multiplication facts when solving multiplication or division problems. Looking for an issue that was common to all was easy to identify: basic facts.

## What are basic facts?

In the previous Mathematics in New Zealand Curriculum published in 1992, basic facts had been defined as addition and subtraction facts to 10 and times tables to 10 x 10. However, with the advent of NDP in New Zealand between 2000 and 2009, basic facts have been redefined to include other useful facts such as 4 x 25 = 100 and compatible numbers such as 52 + 48 = 100. Further information about basic facts can be found in *The Numeracy Development Book 1* under the *Knowledge Framework* (Ministry of Education of New Zealand, 2007).

## Refining the problem by reflecting where we are now

School wide data, compared with the global stages in the New Zealand Framework indicated the majority of the students at the school ranged from Stages 5–7 (an additive stage to a multiplicative stage) with a few students experiencing learning difficulties at Stage 4 (counting 1 by 1 from a set held). In the knowledge framework, students at stage 5 are expected to know their 2s, 5s, and 10s multiplication facts and at Stage 6 to know all multiplication basic facts up to the 10 times tables.

When discussed further the problem was not how to teach the basic facts but how to motivate the students to be able to recall them instantly. The issue was that students had mastered the strategies of how to work out the answers to problems involving single digits but had not mastered the knowledge of instant recall. For example, to work out 6 × 7 they would use a known fact such as 5 × 7 = 35 and then add on another 7 to reach 42.

Van de Walle (2004) advocates the mastery of basic facts as “the development of fluency with ideas that have already been learned” (p. 156). Many of the 485 students had efficient strategies but were not facile. In fact when some students were asked why they didn’t learn their tables the response was frequently “I don’t need to ’cause I can work them out”.

> Fluency with basic facts allows for ease of computation, especially mental computations, and, therefore aids in the ability to reason numerically in every number related area. Although calculators and tedious counting are available for students who do not have command of the facts reliance on these methods for simple number combinations is a serious handicap to mathematical growth. (van de Walle, 2004, p. 156)

The ‘traditional’ way of rote learning multiplication basic facts has long been a popular and somewhat successful process, and there has been resurgence in the popularity of teaching the basic facts in this manner in recent times. Steel and Funnell (2001) have suggested, in a study of students between the ages of 7–12, that they will memorise the multiplication facts quicker using rote learning, but they did place a caveat by saying that it was important that they do understand what they are and how they function.

Van de Walle (2004) also supports the idea of drill when students have learned through a good basic facts programme: “teach for understanding, consolidate through practice and apply through investigations” (p. 157). The idea is to focus on drill when automaticity is a desired outcome. With the students already showing very good understanding about multiplication and how to derive facts from what they knew, the staff felt without this immediate recall of their times tables their students would not reach their full potential in their multiplicative strategies. That was the defining moment: the decision to concentrate on the fluency of recalling multiplication tables.

The research question for this study is "How can the staff, through a whole school approach and home school partnerships, raise an awareness of the importance of learning multiplication facts and increase the multiplication tables knowledge of the students?"

## Process

### Planning

The process up to this stage took three weeks but once the problem was identified planning came relatively quickly. There were some aspects that staff felt they needed to concur with before they could move forward. If they did not all hold common aspirations, there was a chance their expectations would not be met. Everyone agreed:

- that knowing basic facts is critical to success in solving multiplication and division problems in mathematics, science and technology;
- to improving student achievement in basic facts across the whole school;
- to raising the fluency in recall of basic facts, with regular checks, and quality teaching;
- to fostering closer home school partnerships; and
- to be committed to working towards the expected outcomes: (a) that students will become fluent with their knowledge of their times tables, and (b) the whole school average will be in the mid-80th percentile.

With shared beliefs and the question identified the staff deliberated on how best to plan for optimum success. To begin with, they prepared themselves by becoming familiar with literature that was written around the teaching of multiplication tables. Most readings dealt with how to teach for understanding but very few dealt with influencing children to want to learn the facts. Van de Walle's (2004) work on mastering basic facts resonated with their philosophy. It was easy to read and couch this in practical terms.

The next matter was how to gather data so that the school-wide trends could be identified from the subsequent analysis. School-wide testing as an issue was debated fiercely, but because teachers saw a common good they felt some testing was appropriate. From their readings, staff had realised that constant drill and testing could be detrimental to some children's self-efficacy. Whatever they did they had to be sensitive to students' needs. Sessions were to be as enjoyable as possible with challenges and successes for all. Practice and drill had to be meaningful for each student. However, baseline data needed to be accumulated particularly as Year 7 students came from several schools with various assessment profiles.

The following step was to plan what was going to happen in their classrooms. How were they going to go about it? It was decided that they would aim for a period of four weeks and then reflect on what had happened after analysing school wide data. Each class was committed to as much time of the mathematics hour as they needed, five days a week.

The school resources were checked and teachers undertook to search for new websites, games and ideas that may help motivate the students. The task was not just about finding some engaging websites; it was ultimately about selling the idea that ‘it is worthwhile having instant recall of multiplication tables’. Until the students could see that it was plausible and rewarding for them, they would not buy into it. One straightforward idea was to put the students into pairs with one asking a set of ten timed easy multiplication tables (2s, 5s, or 10s) and then the other using a calculator to work out the same questions, also timed. Students quickly saw how much faster it was by recall than using the calculator.

It was realised that students spend a large amount of time with their families and that the school needed supportive links with each family in order to affect the maximum outcomes. Bull, Brooking, and Campbell (2008) found that “parental involvement makes a significant difference to educational achievement” (p. 1). In their best evidence synthesis Anthony and Walshaw (2007) also confirmed what many educators and researchers believe: if parents are involved in their students’ education there will be positive outcomes. Information sheets with suggested activities went home to parents. Individual check sheets were developed to foster a home/school partnership, including the student’s progress and ‘tough’ facts that needed to be learnt. Surveys on whether or not their parents had helped them at home, time spent on their tasks, as well as the students’ feedback on the month, were to be given to all children. Incentives were to be held at a school-wide level in terms of a school swim, and often at class levels in terms of free time or shared lunch.

Finally there was just one more thing to do: decide on a name—the hardest part.

## Acting

*Mega Maths Month*, as it was named, started with a baseline test during Mathematics period. Every student had three minutes to complete the questions, thus ensuring knowledge rather than strategisation of solutions. The baseline test was set for a Friday at 8.55 a.m., to make certain all students did the test. From their results, students identified five of the tables they got wrong or struggled to remember and recorded those on their check sheet. They were the facts they practised during the next week. The class results were sent to the Deputy Principal to enter and find the baseline average for the school. They repeated these steps for the following three weeks. During the four weeks, teachers spent time each day with various activities to encourage the students to become more proficient with the multiplication basic facts they each had according to their ability. At home, the students were expected to devote more time to remembering their multiplication facts, and parents were encouraged to support them.

## Observation

The whole school results after one week quickly jumped from 68% to 87% in 2009, and from 72–86% in 2010. A pleasing outcome was that the year 8 children (in 2010) held their knowledge from 2009. Results showed that in week 3 of 2009 students showed an average improvement of only 1%, with five classes actually going backwards between one and four percent. In 2010 student results increased by 4% between weeks 1 and 2. In both years the students collectively moved more than 15 percentile points but were never able to get into the 90th percentile.

That may have been due to the inability of students to learn the hardest facts of the multiplication tables. LeFevre and Liu (1997) report correlations of error rates with product size. While problems with products greater than 40 comprised 17% of the problems in their study, they accounted for 45% of the errors. Salvo (2006) found similar results on a pre-test that she administered. "Nine of the 10 most missed problems had products greater than 40 and both factors greater than 5. The nine problems, in order from the most missed, were 8 × 7, 8 × 6, 7 × 9, 6 × 9, 6 × 7, 7 × 7, 9 × 8, 8 × 8, and 9 × 9" (p. 583). They comprised 25% of her test items, accounted for only 12% of the correct responses but 40% of the errors and omissions. They were also the problems students at their school consistently identified as their "hard ones".

According to the teachers, incentives appeared to be motivating. However, the students surveyed held different opinions. They felt incentives made little difference to their motivation. Some had even forgotten that there were incentives in place.

Once results from students were compared to their surveys it was found that when parents helped their children they improved the most. It was nearly a 50/50 split of parent support from the whole sample but it was very clear that home support was greatest for students who improved by 30 or more percentage points.

The classrooms which had the greatest success often discussed class and individual targets. One class found the use of a spreadsheet to show the classroom average at a point in time and what it would be if students set and reached an improved score they thought they could attain. That demonstrated to them clearly that if everyone made small improvements it would work towards achieving their overall goal of an improved class average.

## Reflection

It is hard to identify the one key thing that brings success to a student. The school's process indicated that the best results come from a combination of ensuring students' understanding of what multiplication tables are, practice, and family support.

No teacher interviewed for this action research project felt they had found a defining tool. Flash cards, basic rote learning, computer games, and testing each other were all common practice tools. Students themselves identified personal flash cards and games as valuable tools for learning their multiplication tables.

The teachers felt they started out a little disjointed but along the way valued the individual input and team commitment to the process, which gave them a sense of ownership. It has made them look at the activities they have used and question 'Why that one?' They have differentiated some of the tasks they have used for students of differing ability. They have collaborated with colleagues, shared their successes, and talked about improvement. Most importantly they have been the drivers of their own critical reflection.

Questions that have arisen from the process are:

- Is there a need to spend more than one month a year on *Mega Maths Month*?
- What aspects can we make an integral part of our practice?
- Should gender/ethnicity results be looked at more closely?
- How can relationships with the parents who are 'invisible' be improved?

Success in 2011 could come through looking at one of three options:

1. A differentiated programme where some children continue with *Mega Maths Month* and the others who know all their tables become the mentors/partners for the children who are experiencing more difficulty than usual;

2. A 'Maths Matters' programme which focuses on the multiplication strategies being taught, drill (especially on the identified harder multiplication facts), and either an intrinsic (family/peer expectations to do well) or an extrinsic (reward) incentive for automaticity of multiplication facts, which is still under debate; and
3. Students identifying their own style of learning and planning their own programme to help them learn their multiplication tables.

## Conclusion

The school has made considerable changes to their teaching and learning of mathematics through discussion, debate, and professional development. Since 2009 the staff has worked hard to find aspects that, as a school, they could focus on in a collaborative way. What was significant was just how much difference they could make when teachers, parents and students all worked together. It was their first process as a whole staff and it is that story that makes it worth telling.

It was not a huge undertaking but it was manageable and therefore did not seem too onerous a task. It is hoped that by sharing their journey other schools will be tempted to find a problem that they can tackle through the simple action research process. The new knowledge, improvement in practice, communication, and the relationship building with teachers, children, and parents that transpires through the process cannot help but make it a worthwhile endeavour.

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