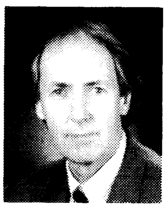
Why are Dutch students good at Maths?

Ken Carr and Jan Gray

In this article we suggest why Dutch students do well at maths (not only in international surveys), and what this means for New Zealand.



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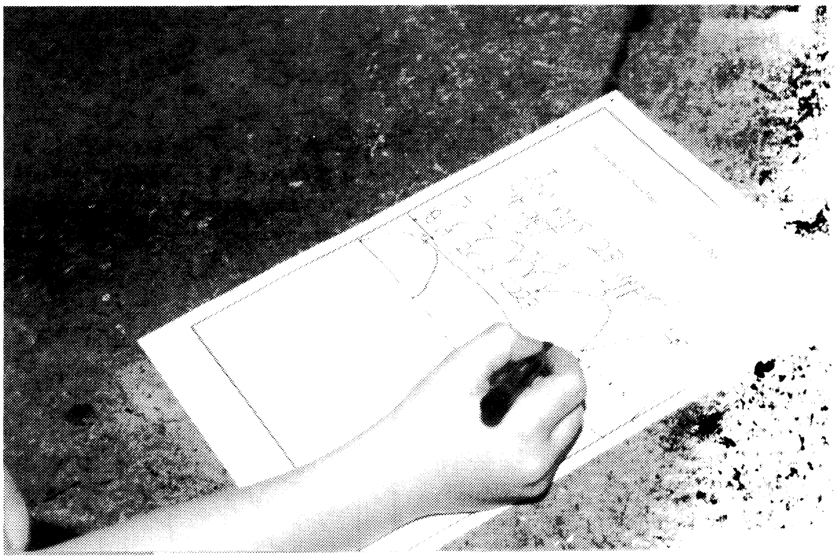
Introduction

Making comparisons of student achievement in mathematics, on an international basis, can be fraught with difficulty. International results are largely based on pencil-and-paper tests. Countries give variable attention to this form of assessment according to the mathematics education 'philosophy' of the



particular country. In schooling systems where students practise the completion of test-like exercises, students may perform well on international surveys.

Caution is also required when trying to decide what international survey results mean for New Zealand educators. For example, it may be easy to attribute how well or poorly students do to certain beliefs and practices that we have developed . Sometimes we form these views without any real evidence. For instance, it is assumed by many that some nations have a student population that is 'naturally good' at maths. Others believe that drilling our children in the operations and associated algorithms at a very young age will enable them to achieve higher in maths.

While simultaneously treating them with some caution, we should not ignore international survey results (Biddulph *et al,* 1997). Readers will know that the top four countries in most surveys of achievement in mathematics are Asian. The next four are often Slovenia, Hungary, the Czech Republic, and the Netherlands (not necessarily in this order).

The processes and background

In this article we suggest why Dutch students do well at maths (not only in international surveys), and what this means for New Zealand. First we should establish that students from the Netherlands DO perform well at mathematics. How can this be claimed?

- International survey results discussed above generally show that Dutch children do well. This is not enough of course
- Traditionally the Netherlands, as

"Realistic contexts are those that are real to the STUDENT herself/ himself."

a nation, has valued trade and commerce - activities that are underpinned by competence in mathematics.

- Many other countries in the world are interested in how mathematics is taught in the Netherlands and are seeking to use some practices from that country as they seem based on common sense.

What, then, are the essential 'ingredients' in the Dutch approach to teaching mathematics. Of course it is not possible to paint the full picture here, but the following give a glimpse.

First, starting in the early years at school, students are encouraged develop a range of counting strategies. In order to develop the feel for number, children count forwards, backwards, in various multiples and use a variety of games and activities. These experiences help prepare students for problem-solving and later formal and informal experiences.

Second, for the last 30 years the Dutch have emphasized the use of what they call 'realistic contexts' in mathematics education. In practical terms this means finding suitable situations in which the mathematical ideas may be embedded. Realistic contexts are those that are real to the STUDENT herself/himself. These contexts may come from both the 'real' and 'imagined' world of the learner. For young children who are starting to learn about addition, the illustrations shown in figure 1 may be used.

Third, the introduction of algorithms is delayed. The Dutch believe that if we introduce children too early to working forms then they will perceive maths as being formal, mechanistic, and (most importantly) without any clear connection to the world in which we live.

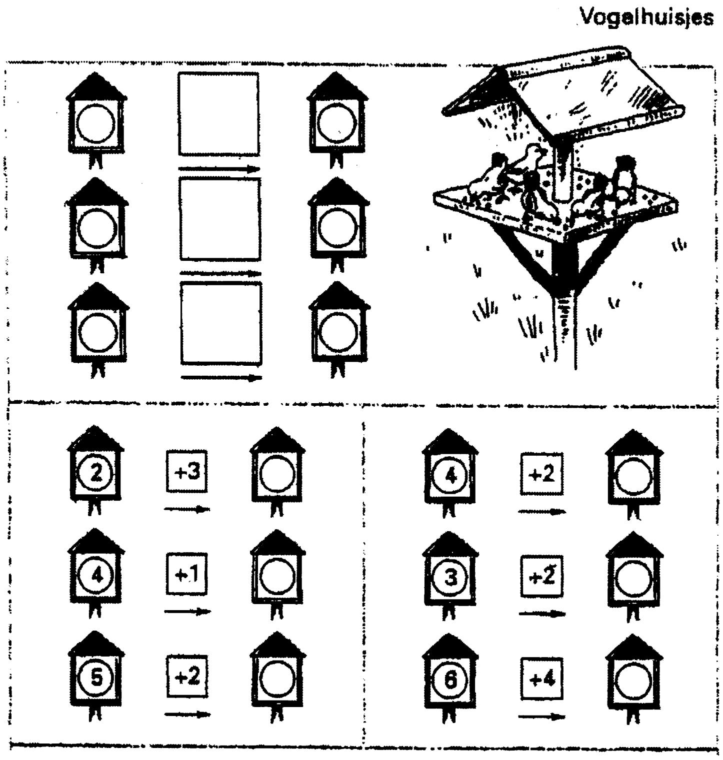


Figure 1: from Boswinkel et al (1997)

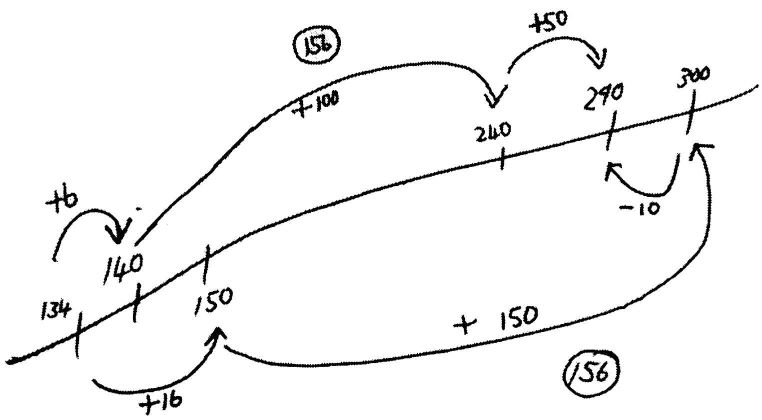
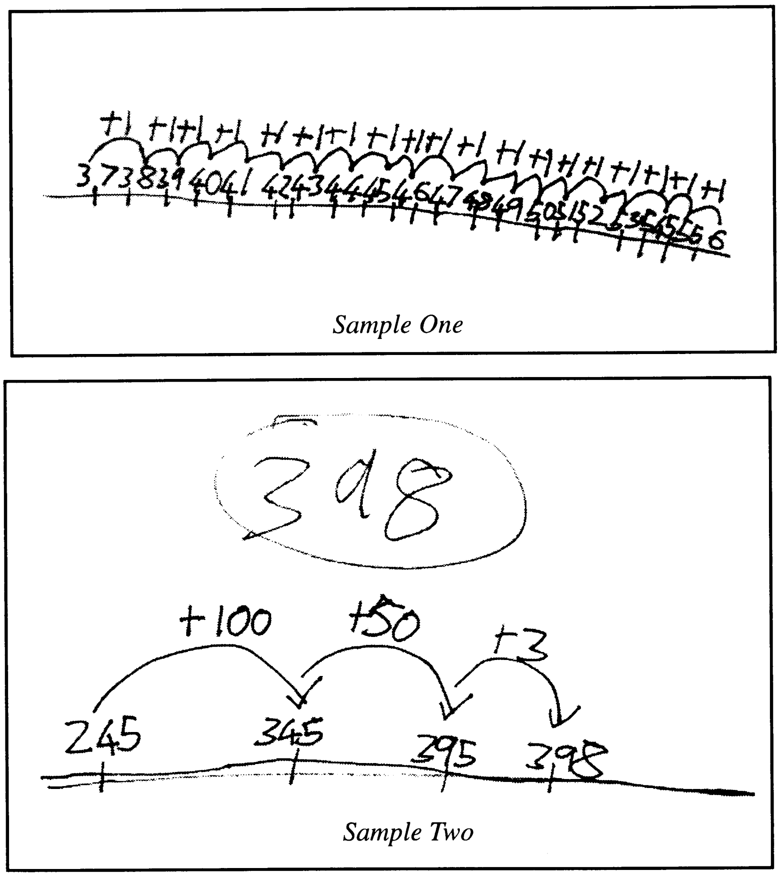


Figure 2: The empty member line - an example

Fourth, several 'devices' have been developed by mathematics educators such as Adri Treffers, Meindert Beishuizen and Koeno Gravemeijer in the Netherlands that they believe will help students understand the maths they are engaged in. For example the empty number line (ENL) may be used to help solve problems with numbers. Teachers present a problem such as *"I am saving for a bike that costs $290. So far I've saved $134. How fmany more dollars still to save?"* Figure 2 shows two possible ways year three or four students might solve this problem.

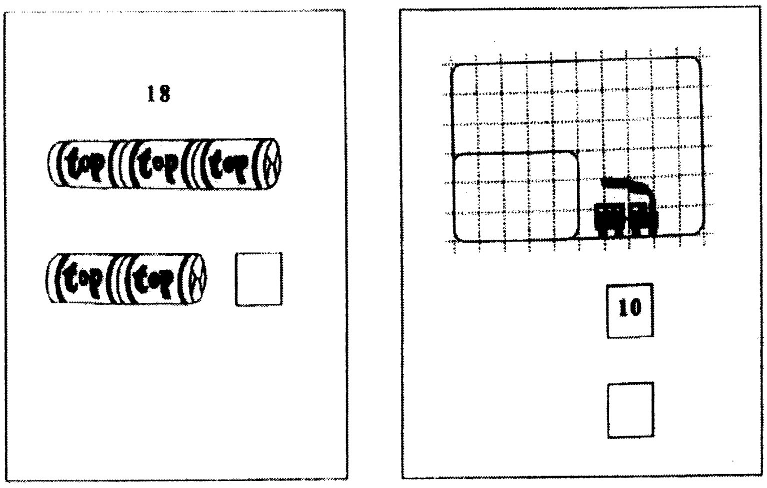
We have tried using the ENL with a number of different age groups within the primary school. Year five and six students who have not seen the device previously tend to prefer the methods that they have learned and internalized and may be reluctant to take it up. At the same time they enjoy the ease of use and the chance to solve a problem in their own way. Year three and four students, on the other hand, are just starting to come to grips with



Sample One

Sample Two

Figure 3:
Child D's work, samples one week apart - empty number line



Instructions to be read aloud:

"There are 18 candies in the whole roll. How many candies do you think there are in the roll that is no longer whole? Write your answer in the empty box."

Instructions to be read aloud:

"There's a train ride in the amusement park. The short ride takes 10 minutes. How long do you think the long ride takes? Write your answer in the empty box."

Figure 4: example from van den Heuvel-Panhuizen (1966)

"One fascinating result of her research has been to show that if students are given a chance to explain their reasoning then they may be correct after all."

understanding the operations. They take on board the empty number line after just a few times of trying it out. It is most interesting to see their development - figure 3 has samples of work with a year three student showing how he progresses from adding ones to trying out a variety of strategies to get an answer.

A significant point in all of this is that the ENL may be used initially as a 'model of' the process the student is working with. With guidance, the student progresses to using the ENL as a 'model for' more powerful and efficient ways of solving problems.

Fifth, an important element in the Dutch approach is what they refer to as the 'mathematising' phase. This is where the maths is 'teased out' of a particular 'real-world' context.

When it comes to assessment, the approach in the Netherlands is to try and embed the assessment items and activities in contexts. So, a teacher might assess number computation through using problems that involve shopping, measurement and sport - often presented through illustrations.

Another prominent maths educator in the Netherlands is Marja van den Heuvel-Panhuizen. Some of her work in assessment has shown very clearly that the traditional pencil-and-paper task we give our students may provide us with very misleading results. One fascinating result of her research has been that if students are given a chance to explain their reasoning then they may be right after all. She calls this approach the 'safety-net question'. In this students give their response and then explain their reasoning (if they wish). An example: students were asked to work out the better sale price for two pairs of running shoes. The discounts were 40% and 25%. Some students gave 25% as the better

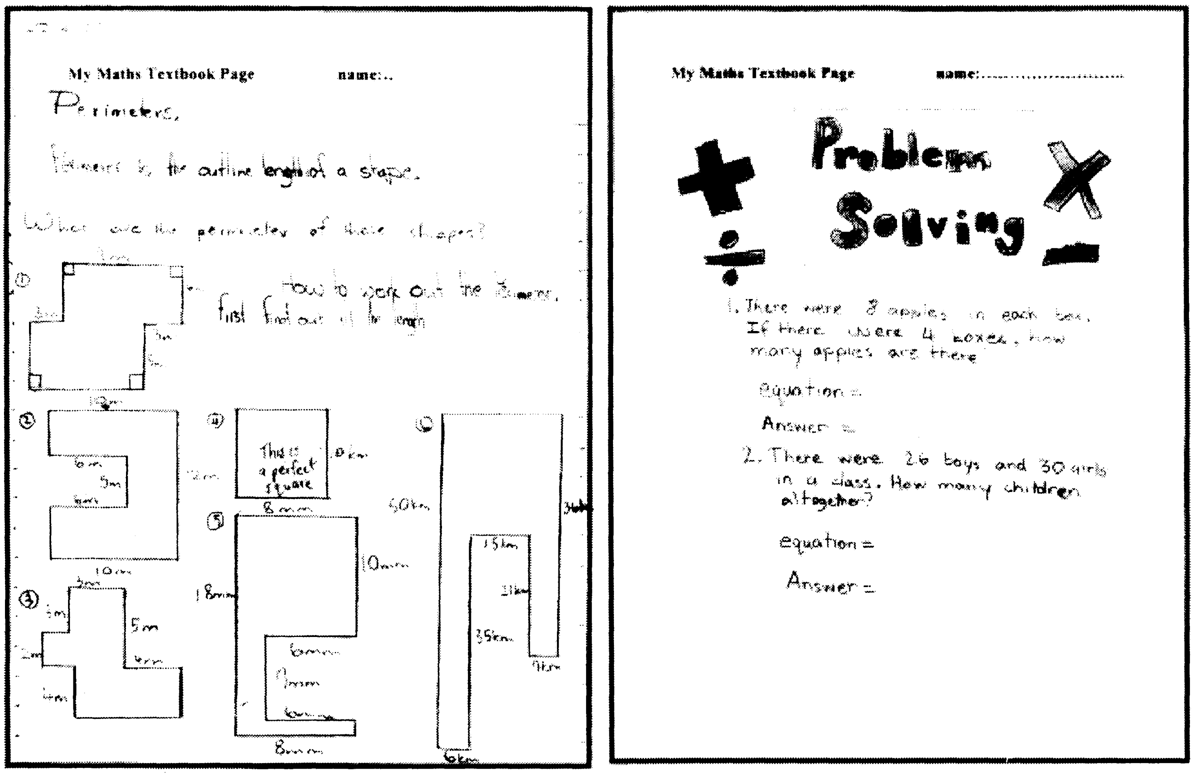


Figure 5: Children writing 'textbook' pages

discount. This indicated to the teacher that these students did not understand percentages. However, in the alternative form of the question where students could *explain* their reasoning, the explanations showed that they did indeed realize that 25% was less than 40%, but in the case of the running shoe prices some thought the 25% discount might be a better buy as we did not know the original price – it may well be lower in the shop offering a 25% discount.

An interesting activity that we have tried with year 5 and 6 students is to ask them to write some pages for a book in mathematics that 'children could use in your class next year to help them learn math' – we got this idea from yet another Dutch math educator, Jan van den Brink. We asked our sample to write one page for us each day over a couple of weeks. Of course, in completing this activity the students reveal what they see as, first, the essential ideas in mathematics (their values in mathematics if you like), second, the way they would like mathematics to be taught and learned by their peers, and third, the type of mathematics programme operating in their classroom. The results were fascinating – two typical pages are reproduced below.

This activity can also be used for assessment purposes. Children will reproduce the mathematics that they know they know. In one sense they are reflecting on their maths knowledge and revealing their ideas to us, but in a manner that is unthreatening.

Conclusion

In this article we have suggested some reasons why students in the Netherlands achieve well in mathematics. We have given some examples of what they do. The important point for teachers in New Zealand is the extent to which we want to take up some of the orientations and techniques from a European country. Can we use some of their ideas? Will they be helpful for students in developing numeracy? We do not know for sure. We do know, however, that there is a great deal of research waiting to be done (and not funded up till now) in the mathematics classrooms of this country.

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