Teachers often use short quizzes as a beginning activity in mathematics lessons. These activities are used as a ‘warm up’ to get their children thinking mathematically. The emphasis is generally on speed and accuracy and these activities provide opportunities for children to practise and reach the goal of automatic recall of number facts. As a teaching and learning strategy for mental computation, however, such activities do not generally provide children with the opportunity to learn or develop their own mental computation strategies. This is especially the case when such activities are followed by exercises in written computation. Another down-side of the emphasis on speed and accuracy is the anxiety experienced by some children. This article sets out some goals for mental computation and provides some ideas for teaching mental computation in the classroom.

More than automatic recall

Mental computation is more than automatic recall. Automatic recall is certainly a very efficient and effective strategy for mental computation, but we can not possibly commit all the possible mental computation problems to memory. It is surprising though what some children and adults ‘just know’ when you start asking mental computation questions. Usually it takes time to think through a way of doing arithmetic in your head. An emphasis on speed does not give children, or adults, time to think about a mental strategy.

Try this problem for yourself:

You’re watching the Melbourne Tigers play the Sydney Kings in a basketball match.

The score is:

<table>
<thead>
<tr>
<th>Team</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney Kings</td>
<td>34</td>
</tr>
<tr>
<td>Melbourne Tigers</td>
<td>73</td>
</tr>
</tbody>
</table>

How many points in front are the Melbourne Tigers?
First of all I split the 24

Jot down your thinking strategy in this thinking cloud.

Did you count on by tens (44, 54, 64, 74) and then take away one? Or did you take away the tens, then take away ones (73 − 30 = 43; − 4 = 39)? Or perhaps you added on to make a ten first and then added on the differences (34 + 6 = 40, + 30 = 70, + 3 = 73; Ans = 6 + 30 + 3 = 39). You may have used extended number facts, that is you just knew that a 9 would be in the answer. Then again you might have done it differently. ‘For most mental calculations there is not one strategy, nor is there a best strategy’ (McIntosh, 1996a). The more strategies that you have at your disposal the more confident you are with mental computation and so are children.

Try another mental computation problem:

I want to know the number of packets of Maltesers we have to sell on a chocolate drive. There are 8 boxes with 2 dozen, that is 24, packets of Maltesers in each box. How many packets are there altogether? How would you work it out in your head?

Jot down your thinking in the thinking cloud.

Did you double (double 24 three times: 48, 96, 192)? Perhaps first you split the 24. That is, you used the distributive law. You renamed and added: (20 + 4) × 8; 20 × 8 = 160; 4 × 8 = 32; 160 + 32 = 192. You may have split it a different way: 12 + 12 and used multiplication facts. Or perhaps you used a different known fact: 25 × 4 = 100; double and take away 8 = 192. Then again you might have done it another way. You probably used a number of steps to get to your final answer. You may also have been inclined to jot down some numbers along the way.

Developing and using a range of strategies

Children understand that being able to calculate mentally is an important skill, especially when it comes to shopping. They know that being able to calculate mentally means that you won’t get ‘ripped off’ at the shops. They will also be able to think of other contexts when being able to solve problems mentally would be useful, such as in sport and when playing games. The understanding of number and the operations that comes from developing mental computation strategies are also useful for algebra. When children rename or rearrange when thinking through calculations they are using the commutative law, the associative law or the distributive law. These are mathematics laws that are used in algebra, for example, to solve equations.
Number sense

An emphasis on automatic recall and speed as mental computation does not value children’s knowledge about numbers and operations. As children learn and use new ways of doing computation mentally, they enhance and demonstrate their number sense. They know lots about numbers. Numbers become flexible, and they know how numbers can be pulled apart and put back together again. When researching the mental computation strategies of children from grade 2 to grade 7, McIntosh, (1996a) found that:

The efficient mental calculators we interviewed appeared to have a range of strategies which they used and adapted flexibly. They did not necessarily perform the same calculation the second time around… but they did show a command of relationships between numbers which they orchestrated efficiently in order to perform a calculation with the least mental strain. Thus they did not need a 'better' short term memory; they simply put fewer demands on it… It would appear that competent mental calculators become so in spite of what happens in the classroom… It is important to expose [the less competent and less confident students] to the more sophisticated strategies partly because these are often, in fact, simpler. How best to expose them to these strategies is not yet clear. (p. 274)

So how can we teach mental computation so that children can be exposed to a range of strategies? I believe we need to:

- allow children to jot down numbers as they are thinking,
- use meaningful contexts, and
- use games so that children can practise mental computation.

Sharing with thinking clouds

You will need a set of thinking clouds. The thinking clouds are really labels with names of strategies that children may use on them. For example, the names could be: just know it, count on, make a ten, double, rename, split up the number, add the tens first, another way. There are many others. Some of the thinking clouds should be blank.

1. Pose a mental computation problem for your children. Give them time to think and come up with a solution.
2. Ask the children to talk to other children in the grade, find others who have solved the problem in the same way, and form a group.
3. Ask one representative from each group to explain their method to the class. As they explain their method ask them to jot down numbers or steps on the board so that other children can track their thinking.
4. Ask the child(ren) to pick a thinking cloud that describes their method or make up a new cloud to go with their method.

As you work through a range of problems involving the different operations, the class can build up a display of thinking clouds. Possible names for strategies can be found in curriculum documents, for example, Mathematics: A Curriculum Profile (1994) and mathematics curriculum documents produced in your state. McIntosh (1996b) has
Double digit

You will need one die, a pencil and paper. Each person will need a score sheet like this:

<table>
<thead>
<tr>
<th>TENS</th>
<th>ONES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How to play:
1. Each person takes a turn rolling the die, and each player writes the number in either the tens or the ones column of the score sheet.
2. When a number is entered in the tens column, 0 is written next to it in the ones column. Thus 4 written in the tens column counts as 40.
3. After seven rolls of the die each, the players add up their numbers. The player who is closest to 100 without going over wins. If you go over 100, you are out.

How close can you get?

A card game for 2 to 5 players.

You will need a deck of cards. Remove the tens and picture cards from a deck of cards, leaving ace to nine for the game.

How to play:
1. Shuffle the cards. Deal each player 4 cards, face down.
2. Turn up 2 more cards. The first card goes in the tens place and the second in the ones place to form the target number. For example, a 6 then ace, becomes 61.
3. Now the players turn up their four cards and arrange them into two two digit numbers, so that when they subtract their two numbers the result will be as close to the target number as possible.
4. To score each player finds the difference between his or her result and the target number. For example if the target number was 61 and a player had A, 5, 3, 9, the best she could do would be 95 - 31 = 64. Her score would be 64 - 61 = 3 for that round. Note that you can go over or under the target number.
5. For the next round, turn up two new cards from the deck to form the next target number. Players can choose to use their same four cards or deal out new cards.
6. At the end of, say 5 rounds, the player with the lowest total score wins.
First of all I split the 24 documented strategies for adding single digit numbers. Older children could research the different strategies used for a particular problem. The video Real Maths School Maths (MCTP, 1988) shows adults solving a division problem and is a good starting point for such an activity.

Games

Many games provide opportunities for children to compute mentally. When using games allow the children time to learn the rules and play the games. Then discuss the key elements of the game. In particular discuss the way that they are doing their mental calculations and the strategies that they are using to win the game. Here are two suggestions:

Double digit

This game requires children to add mentally and so the full range of mental computation strategies could be used. Successful strategies for winning the game also involve an understanding of chance. The game could be adapted to use three digit numbers as well and thereby increase the level of difficulty and the range of strategies that children may draw upon for mental computation.

How close can you get?

Children will use a range of mental strategies for subtraction, including subtracting the tens first. The visual cue of the cards will assist them. Children could be challenged with making the game more difficult to play or easier so that younger children could play.

For younger children there are many variations of games using dice and cards where children can calculate totals and differences mentally or with the aid of materials.

Conclusion

Encouraging children to use more efficient and diverse mental strategies is a challenging task. Children, especially those who are less competent or confident, will stick with methods such as counting and written algorithms, especially when under pressure. Encouraging children to listen to strategies explained by other children gives them a window into other children’s mathematical thinking with and about numbers.

References


McIntosh, A. (1996a) Mental Computation and Number Sense of Western Australian Students. In J. Mulligan & M. Mitchelmore (Eds) Children’s Number Learning, A Research Monograph of MERGA and AAMT. Adelaide: AAMT.


End note

‘Double Digit’ and ‘How Close Can You Get?’ were first published by MAV/AAMT in HOMA – Home Mathematics (1988). This publication is now out of print so the rules for these games have been reprinted here.

Colleen Vale is a lecturer in education at the Victoria University of Technology in Melbourne.

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