The importance of alternative strategies to using the algorithm

Vertical algorithms - what are they? and when should they be introduced at school?

A vertical algorithm is one form of recording how to add or subtract or multiply numbers. It is a step-by-step procedure for finding answers that is based on numbers in their place value 'columns.'

46 +
72
138

For many years it was the only way children were taught to solve addition and subtraction tasks at school. However, many children, and adults, have learned this procedure but do not feel confident in understanding the mathematics behind it or require 'pen and paper' to work out the answer.

Algorithms are not mentioned specifically in ACARA's Australian Curriculum: Mathematics but are introduced as a written strategy in the NSW Mathematics K-10 Syllabus late in Stage 2 (approximately year 4). They are more of a recording mechanism than a 'working out' strategy. Many children may know how to 'do' algorithms when they are presented like the example above, but if they do not understand the mathematics may have difficulty for say subtraction. They may see the example below and think "I can't do 6 - 9 so I'll just do 9 - 6."

E.g. 26 -
19
13

Mathematics should make sense to children and they should be encouraged to understand what they are doing and why it works.

Mental strategies - what are they? and when should they be introduced at school?

When teachers talk about mental strategies they mean that children can think about the question in their head and give a way of working it out that holds meaning for the child about the numbers.

Examples of mental strategies include:

- Using 'turn around facts' *"I know that 7 + 4 equals 11 so 4 + 7 also equals 11"*
- Bridging to ten *"To add 8 and 6 I can add 2 more to the 8 to get 10 then I know 4 more is 14"*
- Near doubles *"When adding 25 + 24 I can double 24 and add 1 to get 29"*
- Compensation *"To add 54 + 19 I can see the 19 as 20 get 74 then take 1 away to make 73"*

Mental strategies are introduced from about year 1 when children start to learn about adding and subtracting. As children develop these different ways of solving problems they also learn ways to write them down to share their ideas with others. Once children have a range of ways to work out problems, then algorithms can be introduced as another way of recording (in short hand almost) what the solution is, generally for problems with larger numbers.

Why should my child have to know other ways to solve problems if they can already use the algorithm?

Mathematics is about patterns and being able to use and apply basic ideas to solve much more complex problems. If a child only has the algorithm as a way to work out the answer, they will miss out on seeing the relationships between numbers and may not make the connections across mathematics areas that are needed as a base for secondary mathematics. For example,

24 x	12 x	48 x
8	16	4

A child may be able to solve these questions using an algorithm following the procedure and then find they all have the same answer. But they may have missed seeing the relationships between the questions in the process. Children who have strong mental strategies will have noted the 'doubling and halving' pattern of these examples, knowing the answers will be the

same without having to solve them at all. Or may even know to continue the pattern to 96 x 2 and solve that task instead of all the others.

It is important to note that the algorithm is not 'the highest' strategy, even once children know how to use it, they shouldn't stop using other strategies, thinking that mental strategies are less valued. It is more about knowing when to **choose** to **use** the algorithm and when to choose an alternate strategy.

Five reasons to build children's mental strategies

1. **Mathematics is not just about getting the right answer**

Correct answers are necessary, but how you got them is more important, specifically for young children. As teachers we want to make sure our young children do not become 'stuck' using strategies such as counting by ones forever. The only way to find this out is to ask them. Being able to share your ideas and understanding and to prove how you know something works or is true is an important aspect in mathematics.

2. **Flexible strategies are needed in other areas of mathematics**

Understanding how numbers work and what to do with them mentally means you have a 'bank' of ways to work things out, especially when things go wrong. If I know mentally that 16 is the same as 10 + 6, I can use that to work out 8 x 16. I can work out 8 x 10 then 8 x 6 then add them together. If I also didn't know what 8 x 6 was, I could either do 4 x 6 and double the answer or do 3 x 8 and double the answer.

3. **There are times when it is 'quicker' more efficient *not* to use an algorithm**

When there are just 'random' numbers to add like 2345 + 137 + 84 + 9, it makes sense to write them as a list and use an algorithm to find the answer. But say my question was 4002 - 3998, in this example it is much more efficient (faster) for my brain to count up from 3998 to 4002 and get an answer of 4, than to write those numbers out as an algorithm, then use 'borrowing' or 'trading' to find the answer.

4. **Knowing how to solve maths questions in your brain builds confidence**

As mentioned above, many children and adults know how to 'do' algorithms but do not feel confident in their maths ability and may not like maths at all. As teachers, we want children to look forward to learning about maths and to feel success in both working out answers and knowing why it works. Not being reliant on an algorithm (especially for small facts to 20 like 12 + 7) gives children confidence that they can work it out using their brain. Working hard pays off

and all children can be successful in mathematics, as can all adults. You may just not feel that way, yet.

5. **If students know how numbers work first, the algorithm won't be difficult to understand**

The subtraction examples provided above (26 - 19) clearly shows a child that does not understand how numbers work. Children that may still be counting by ones to work out addition and subtraction should not be exposed to algorithms. Children who know how numbers work and know that 26 is made up of 2 tens and 6 ones and know that they can break 26 into 10 and 16 to then subtract the 9, won't have difficulty if introduced to the procedure of the algorithm. However, questions involving 2-digit numbers like 26 - 19 should be solved mentally (e.g. starting with the 19 and adding 7 to make 26). In NSW, algorithms are introduced with 3 and 4-digit addition and subtraction.

Practical ways to support your child's mental strategies at home

- Play games like Yahtzee® or Scrabble™ where adding your total score mentally as you go is a focus of the game. Yahtzee® is especially good for multiplication and Scrabble™ is good for addition
- During maths homework ask your child *"How did you work it out?" "What number did you start with?" "Can you show me another way?"* Even if you do not understand the mathematics, having your child explain what they are doing is useful. When children play 'teacher' and try to teach you, they are building strong links in their maths knowledge
- Work with your child to mentally work out percentages while shopping. If there is an item for $60 with a 50% discount, ask them how to work it out. Do they relate 50% to half and see that you would get $30 off?
- Watching Letters and Numbers and pausing after they choose the numbers so your child has more time to work out a solution, or playing the online version of the maths game https://nrich.maths.org/6499

Helpful Websites for parents

You might like to explore these websites to support you in talking with your child about maths

https://talkingmathwithkids.com/

https://mathbeforebed.com/

https://www.youcubed.org/resource/parent-resources/

https://nrich.maths.org/parents

These two articles on algorithms may also be a useful read

http://www.marilynburnsmathblog.com/algorithms-are-not-enough/

https://primarylearning.com.au/2019/04/15/trading-in-the-algorithm/

References

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Australian Curriculum and Reporting Authority [ACARA], 2015. Australian Curriculum: Mathematics retrieved from https://www.australiancurriculum.edu.au/f-10-curriculum/mathematics/ on 22 April 2019.