CAMBRIDGE Mathematics

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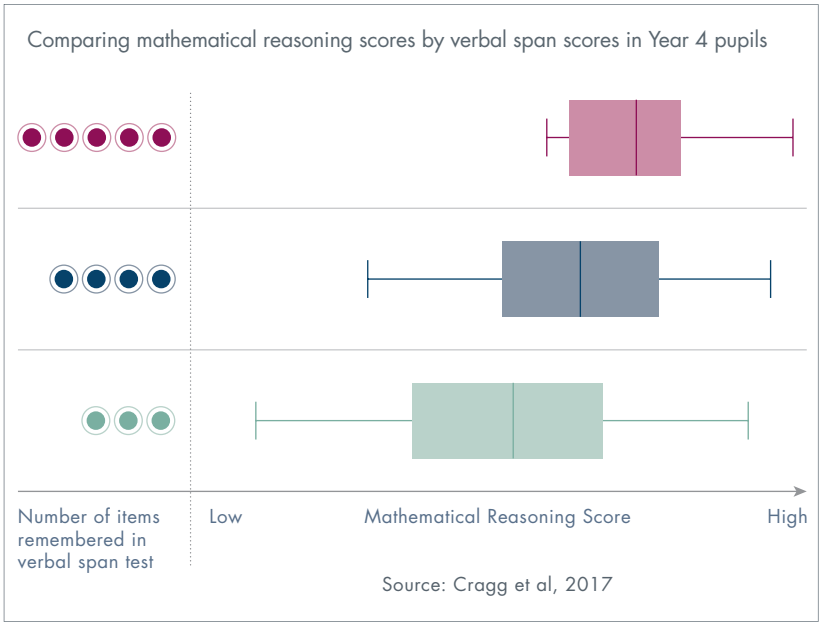
RESEARCH, FILTERED BY CAMBRIDGE MATHEMATICS

## TALKING POINT:

## WHY IS WORKING MEMORY IMPORTANT FOR MATHEMATICS LEARNING?

## IN SUMMARY

- Working memory restrictions limit the amount of information that students can hold in mind
- Young children have a very small working memory capacity and capacities within a typical class will vary widely
- Students who struggle with mathematics may have difficulties with working memory; this explains around 25% of differences in mathematical outcomes
- Classroom strategies such as using manipulatives, repetition, and breaking down tasks into smaller steps may help to reduce working memory load
- Working memory training alone does not lead to better outcomes in mathematics attainment




### 1

Working memory is a cognitive system that holds and manipulates information in the mind for a short period of time; for example, we use it when we have to remember items for a shopping list, follow directions and use a recipe. Information held in working memory is very fragile; it can disappear in the face of distraction or quickly fade away if not rehearsed[1]. The most well-known model of working memory is that of Baddeley and Hitch (1974)[2] which suggests there are separate short-term stores for verbal and visual/spatial information.

**IMPLICATIONS:** Students may require written instructions or reminders as their ability to remember verbal instructions is limited by their working memory

### 2

There is a limit to the amount of information that can be held in working memory. For an average adult, this is approximately five unrelated words or numbers, or a sentence of around 15 words[2]. However, the average five-year-old can only remember 2 unrelated words or numbers[3]. Working memory capacity gradually increases during childhood, levelling off around 14–15 years of age[4]. There is also a great deal of individual variation; within a class of Year 2 students (6–7 years) there may be children with similar working memory capacity as an average child in Foundation Stage (age 3–5), and some more like an average Year 5 pupil (9–10 years)[5]. Some pupils who struggle in class may do so, at least in part, because of poor working memory; forgetting lengthy instructions or losing their place in a task[5].

**IMPLICATIONS:** Teachers should be aware that when children start school they can only hold a very small amount of information in their minds at one time

Students' working memory capacity will vary widely within a typical class, which teachers should plan for carefully

Pupils may experience difficulties in class due to working memory limitations

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3

Working memory is involved in all academic subjects, but is particularly important for mathematics[6]. Individual differences in working memory capacity are associated with differences in mathematics performance, even many years later[7,8]. Around a quarter of the variance in mathematics outcomes can be explained by differences in working memory capacity[9], and it is involved in both learning new mathematical material and also in performing already-learned procedures[10]. Most studies exploring the role of working memory have focused on arithmetic; within this area, working memory is needed to carry out procedures, for example by holding interim totals in mind and keeping track of counting steps and also in learning and retrieving number facts from memory[11]. It is likely that working memory is also important in broader mathematics topics including algebra and geometry. Children with mathematical learning difficulties have been found to have reduced working memory capacity compared to their peers[12] and they may rely for longer on more basic strategies for solving problems such as finger counting[13].

**IMPLICATIONS:** If a child is struggling with mathematics, particularly arithmetic, then they may have difficulties with working memory

A substantial proportion of differences in mathematics outcomes can be explained by differences in working memory capacity

4

Evaluating and managing the working memory demands of classroom activities can help all children's learning. Working memory capacity can be measured using **simple games and tasks** and demands can be reduced with strategies such as regularly repeating key information or instructions; providing external supports (manipulatives/number lines); encouraging children's use of memory aids and other strategies like rehearsal and breaking down multi-step tasks into smaller tasks[14]. These strategies may be particularly helpful at times when new mathematics material is being introduced. Working memory training programmes (repeated practice of computer-based tasks) have been proposed to help children who may have academic difficulties due to low working memory capacity[16]. Although there is some evidence that this type of training may improve children's performance on working memory capacity measures[15] there is no reliable evidence that this leads to improvements in mathematics attainment[16].

**IMPLICATIONS:** Strategies such as repetition, using manipulatives, memory aids and breaking down multi-step tasks can be used for all students

Isolated working memory training may not lead to improvements in mathematics attainment

'it is clear that children with MLD have some form of working memory deficit'
**David Geary**

'remembering and following instructions represents one of the major challenges faced by children with low working memory'
**Gathercole et al, 2008**

'Re[garding] struggling learners, who maybe have poor memory skills; the key here is to develop their reasoning skills and their ability to make connections'
**Debbie Morgan, 2015**

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