Working Memory and Learning

a booklet for teachers, parents and carers

The Psychological Service

SOUTH LANARKSHIRE COUNCIL

EDUCATION RESOURCES

Introduction

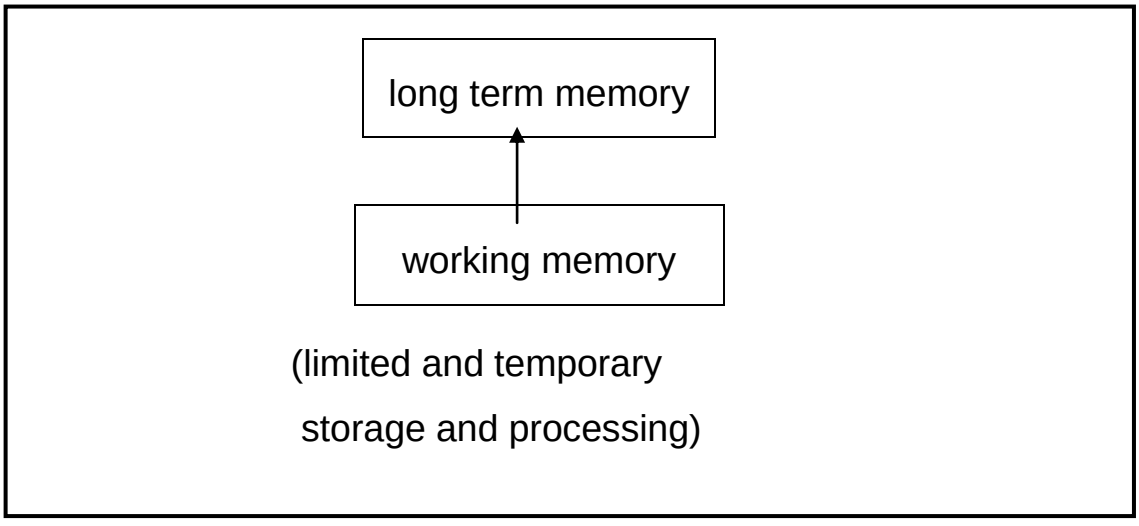
This booklet aims to bring to the attention of teachers, parents and carers new discoveries about working memory and its importance in children's learning. It also aims to suggest ways of supporting children with working memory difficulties.

What is working memory?

Working memory can be thought of as a kind of mental workspace or jotting pad in which we can hold information for brief periods of time, while performing other thinking or mental processing tasks. For example, when we are carrying out a mental arithmetic task we are relying on working memory. Key features of working memory are:

- its capacity is limited
- storage is temporary (e.g. for only a few seconds unless it is rehearsed subvocally)
- once information has been lost from working memory it cannot be recovered. (e.g. have you ever forgotten a phone number or a set of directions?)

We can represent working memory as follows:



From this model it is clear that all the material – (e.g. facts, information, concepts) – in long term memory firstly has to pass through working memory.

The development of working memory

Working memory capacity increases from childhood through to late adolescence when adult levels are reached. Within any given age group, however, there is a wide variation in working memory capacity between individuals. At age 7, those children who have a working memory capacity within the bottom 10% for that age group have working memory capacities less than that of 4 year olds with average working memory capacities. At age 14, some children (10%) have a working memory capacity similar to that of the average 10 year old, while others will have already reached adult levels.

How does working memory relate to learning?

Working memory is vitally important for learning. Children's progress in reading, maths and science has been shown to be closely related to their working memory capacities throughout the years of formal education. Measures of working memory capacity as children start school have been found to be accurate predictors of attainment in reading and maths several years later. In the middle years of secondary education, strong positive correlations have been found between working memory capacity and attainments in reading, maths and science.

Working memory and learning difficulties

Children with poor working memory capacities often encounter difficulties with reading, writing and maths and their memory scores predict the severity of their learning difficulties.

Why do children experience difficulties?

All classroom activities involve demands on working memory. In reading and decoding, the child has to identify the letters, sound out the individual letter, hold the sounds in working memory, then blend them together. In reading comprehension, the child has to read the individual words, then hold the words that have been recognised in working memory long enough to let them link the words together in order to extract meaning. In writing, the child has to hold the sentence they are trying to write in working memory while they are trying to spell the individual words. In maths, success is heavily dependent on the ability to store number facts and bonds. The poor rates of learning in children with low working memory capacities are due in large part to working memory overload in structured learning situations, causing them to forget crucial information and fail to complete tasks. Over time these difficulties become cumulative and the children fall further and further behind.

How can we identify children with poor working memory capacities?

The following features may be indicative of difficulties with working memory:

- slow academic progress
- having good relationships with peers but often being reserved in group situations in school
- failure to follow instructions
- failure to complete tasks
- having difficulties in following sequences
- appearing to be inattentive and distractible
- eliciting comments from teachers and from parents such as: ‘in one ear and out the other’, ‘ he never listens to a thing I say’

Working memory difficulties can also be identified by using one of the South Lanarkshire Council Psychological Service working memory checklists as early as P1. These are available from the school psychologist.

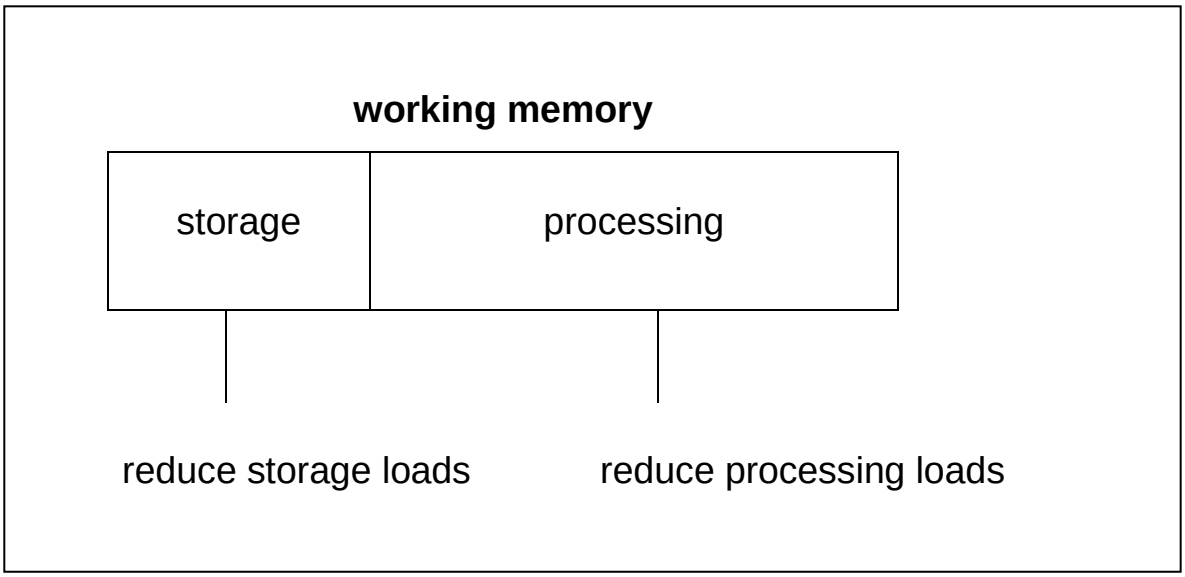
Children who have working memory difficulties are often acutely aware of their problems. It is helpful and useful to ask them about their experiences in trying to learn.

What can we do about working memory difficulties?

It is the overloading of children’s working memory capacities that leads to their learning being affected. The fundamental strategy therefore is to prevent children’s learning from being delayed by preventing working memory overload in the first place. This means accommodating to the child’s level of working memory and modifying the structure of learning activities. Change in the ecology of the classroom can enable children to complete the tasks with which they have previously struggled.

Helpful strategies

We can support the learning of children with low working memory capacities. There are two main approaches. One way is to reduce the working memory loads involved in learning tasks in order to prevent overload. This approach can be represented as follows:



Specific strategies involved in applying this approach include:

- reducing the amount to be remembered (e.g. by using short sentences and cutting down the number of steps in an instruction)
- increasing the meaningfulness and familiarity of the material (e.g. by reviewing prior learning that is relevant to the activity at hand)
- restructuring complex tasks to form sets of independent steps in order to prevent place-keeping failures (e.g. instructions given out as numbered points on a work sheet)
- repeating important information – either by the teacher or a fellow pupil designated as a memory guide (do not wait for the child to ask for help – they may be reluctant to do so)
- asking the child to repeat the information (this helps the child to retain the information longer and promotes the self-help strategy of rehearsal)
- teaching and encouraging note-making and the use of diagrams (this promotes the development of self-help strategies)

The second approach aims to help the child to process tasks by providing external memory aids. This approach can be represented as follows:

working memory

storage	processing
external storage	

External memory aids are normally visual or practical tools, which can directly provide crucial information at risk of being lost from working memory, so that processing can be successfully completed. The proximity of the aids is important here. An aid on the child's own desk is much more helpful than one at a distance such as a graphic on the blackboard. Children seem to lose information between looking up at a display and returning to the task. Possible memory aids include cubes, number lines, multiplication squares, calculators, audio-recorders, computer software, wall charts and posters.

The strategies which aim to reduce working memory loads and those designed to provide external memory support are most effective if used in combination.

Self-help strategies for supporting memory

Providing children with self-help strategies enables them to overcome their memory problems and promotes their development as independent learners. This is particularly important for older children at secondary school. These strategies include:

- requesting help when important information has been forgotten
- rehearsing verbal information that only has to be remembered for a short time
- writing down important information immediately
- using visual devices such as flowcharts, mindmaps and diagrams to depict the structure of complex tasks

Conclusion

It is a statistical certainty that there are children and young people with working memory difficulties in every class in Scotland. If we recognise these children's difficulties and accommodate to them we can prevent failure and raise attainment. It is hoped that this booklet is found to be helpful in raising awareness of the issue and in highlighting potential solutions.

Moving forward

- further information on working memory and advice on classroom interventions is available from your school psychologist
- a training course for staff is also available via the school psychologist.

Further reading

Gathercole, S.E., and Alloway, T.P. (2008). *Working memory and education*. London: Sage Publications

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