

Dyslexia and Mathematics

Can Stern's Structural Arithmetic Materials Help?

Cognitive learning systems and difficulties with maths:

Children with dyslexia may have all or some of the following difficulties.

1. Oral language weaknesses
2. Sequencing difficulties including left/right orientation
3. Memory limitations: short term, long term and working memory
4. Auditory and visual processing vulnerabilities
5. Slow processing speed
6. Weak conceptual knowledge
7. Weak non-verbal spatial abilities

Many of the underlying difficulties of dyslexia could also be the core factors affecting progress in maths and a significant proportion of dyslexic children have difficulty learning maths. Many of these children have difficulties with the surface aspects of numeracy rather than an intrinsic lack of number sense which is now often referred to as dyscalculia. This article intends to address these surface aspects rather than the profound difficulties in having a feel for numbers that characterise the dyscalculic child. It can however be mentioned that Stern materials can also help dyscalculic children but they would need to spend longer on certain aspects of the Stern programme to equip them with a 'toolkit' for numeracy before moving on to other areas of the programme involving the beginnings of basic calculations.

What is Stern's Structural Arithmetic?

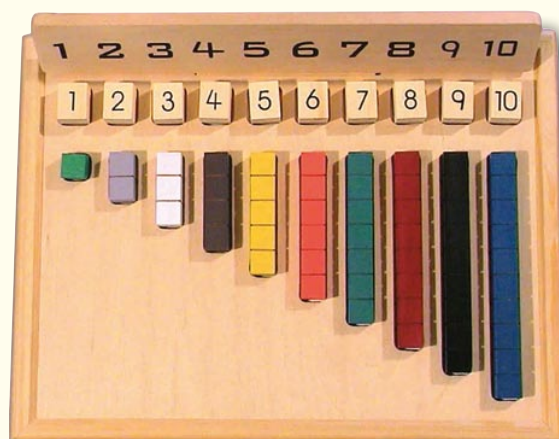
Stern's multi-sensory maths system was designed to develop a child's emergent number sense by building-up number knowledge and number facts in a logical and structured manner thus enabling children to think logically and reason mathematically. Stern facilitates the understanding and application of the four number operations.

Since the system is based on two tangible sets of number representations, the blocks and patterns promote a clear image of number in the concrete enabling pupils to discover for themselves all of the attributes on a physical level. When numerals are introduced they correspond to the blocks and patterns by embodying the intrinsic qualities and values of those numbers.

Each piece of Stern apparatus has a unique function, as well as contributing collectively, and shows the child familiar aspects of number in a different light. The strength of this system is the maintenance of subliminal stimulation of number relationships in the form of images, whilst keeping them in the child's view on a concrete level.

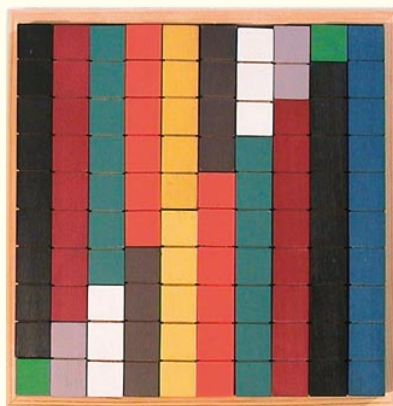
It is necessary to look at some of the main underlying difficulties of dyslexia in order to consider if Stern materials can help.

1. Most dyslexic children have some oral language weaknesses, especially when it comes to learning new vocabulary. The language of maths can pose a problem. The Stern programme is particularly thorough in the way it teaches maths vocabulary in a multi-sensory way to facilitate the child hearing and using the maths words in a meaningful context.
2. Sequencing and left-right orientation weaknesses that interfere with the learning



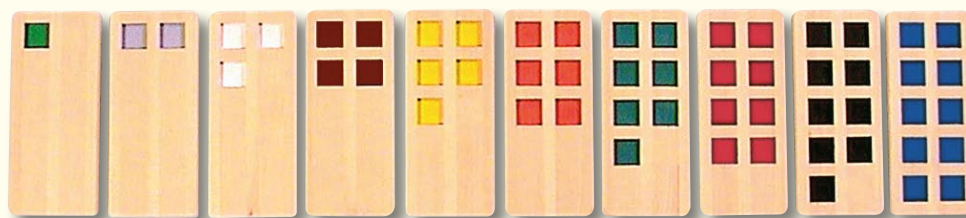
involved with reading and writing of two digit numbers can make some aspects of maths confusing. The Stern 10-Box and blocks help children to gain experience with the commutativity principle by seeing two sets of like blocks that can be switched around and so discover that the order of the addends can be changed without changing the sum, thus grasping the interchangeable nature of addition (and later with multiplication).

3. Sequencing errors are reduced through working with different arrangements of equipment to strengthen learning. They learn about size relationships and measuring with the number blocks in the Counting Board. They 'see' and 'feel' that each length is one unit longer in the sequence from 1 to 10, or one unit shorter in the reverse order. Children can 'see' where each block 'lives' in the sequence as well as the relationships they have with each other.
4. Auditory and visual memory limitations that are characteristic of many dyslexic learning patterns are supported by Stern materials. These limitations may be in short term, working and in long term and/or visual memory and respond well to the multi-sensory approach of the Stern programme. It also helps the child's memory to be able to stay focused on the exact numbers whilst performing calculations with those numbers. The child may be able to build up a more explicit mental image by using the materials regularly so that they can remember them even when they are not present.



5. The children with poor auditory discrimination and perception who find it difficult to discriminate and perceive the difference between the 'teen' numbers and the 'ty' numbers, will find it easier when the numbers are built in the Dual-Board or located in the Number Track.
6. Stern can make concepts and procedures more explicit for children with poor visual perception as part of their non-verbal learning difficulties. The Dual Board makes the concept of place value explicit for two digit numbers. Children gain insight into the relationship between the role and the position of each numeral. The size of the two compartments guide the children when building numbers and are easily placed correctly. 10 ones equal 1 ten is seen clearly when filling up the 'ones' compartment with unit cubes. A 10-block can be laid on top to show they are the same.
7. Children with slow processing speeds who work at a slower pace than the oral presentation by a teacher may find it hard to follow. Stern materials enable the child to grasp the verbal meaning while experiencing the visual and tactile associations that the materials provide. This leads to some children understanding maths lessons more easily.
8. Children may not have developed much conceptual knowledge about numbers due to their dyslexic learning difficulties, or may have other problems that could be investigated by an educational psychologist using a test such as the WISC IV. They could also be screened for Dyscalculia on the Butterworth screener.
9. With explicit multi-sensory teaching, these children may also be able to build up their conceptual understanding in due course. If

this conceptual understanding fails to occur easily, then it may be advisable to consider a deeper

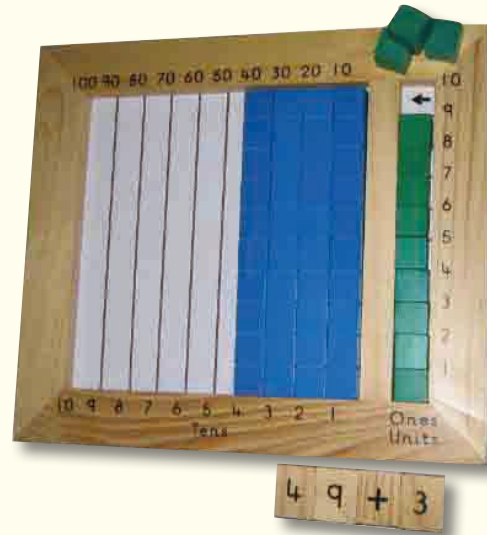


difficulty which could then be described as dyscalculia. The Stern materials could still help the dyscalculic child but the materials might be used more selectively in an even more structured and controlled way which is dealt with in a further article.

10. Stern develops concepts by measuring, not by counting. There is opportunity for visual and auditory input through the teacher's explanation; modelling; the child's own commentary to peers and the incorporation of role play. The activities provide progressive repetition through kinaesthetic input. All these factors strengthen the child's own developing mental strategies providing multi-sensory experience from the formation of imagery, building concepts and enhancing storage and recall.
11. Weak spatial knowledge could be strengthened through regular use of Stern blocks and patterns of cubes. Children learn to recognise patterns of cubes at a glance and then check their patterns by placing the cubes into the empty insets in the boards to verify their visual perceptions against their motor and tactile senses. The process of recognising and constructing number patterns also calls for spatial thinking, and will be reinforcing already developing abilities such as left/right orientation, sequencing; hand-eye coordination, one-to-one correspondence, as well as estimation of quantities, and the concepts of too many and too few.
12. Stern impacts on learning by aiding the development of spatial thinking and reasoning. Whether children are measuring blocks or working with patterns of cubes, they are applying spatial thinking, to help them reason. Each experiment leaves an unforgettable mental picture to turn around in their minds to explore new relationships. Unfamiliar maths language is clarified by the practitioner through concrete demonstrations and further reinforced and linked to the child's actions with the apparatus. By following spoken directions, children are able to develop receptive language and this is a means of assessing their receptive language acquisition. Stern is a system of errorless learning where misconceptions

in the child's understanding will be seen immediately and acted upon through further exploration and practice.

Dr Catherine Stern, mathematician, child psychologist and Montessorian, (Children Discover Arithmetic) introduced us to a specific pattern structure to encourage cognitive development such as left/right orientation.



Whilst the blocks facilitate much of the learning, the Pattern Boards and cubes provide more opportunities to develop concepts based on the characteristics of odd and even numbers.

It is easy to teach children the quality of evenness and oddness with this specific pattern structure. The even patterns all have 'partners' and the odd patterns have an 'odd man' or a 'driver'.

The Pattern Boards

Once number names have been assigned and internalised this frees up space and time within the limits of working memory to better focus on the learning new concepts. Adding 1 to a number in the 10-Box and again with the cube patterns shows the different ways Stern helps children to access the same concept. Children are rather amused to see that adding an extra cube to a number pattern causes the next higher number pattern to appear! Equally with subtraction, that removing one cube gives the next lower number. Also, with the addition of one cube, children see an odd number become an even number and an even number become an odd number. It is easy to show that if you add nothing to a pattern it stays the same.

When adding 2 or subtracting 2, using the patterns, it is visually very clear that this results in the next even or odd number, depending on the starting point. For example, by direct experience, the child sees that if 2 cubes are added to 4 then the next even number is the result.

Number facts

There is greater impact and opportunity for successful learning of number facts to 10, (and 20), developing strategies that lead to internalisation of facts and speedier recall.

Through structured, small-step activities and games, pupils work with combinations of blocks in number boxes to acquire the basic addition and subtraction facts with numbers up to and including 10. Beginning with the 10-Box, (see fig 1) children fit pairs of blocks into this self-checking device like a puzzle. The materials encourage children to think and reason for themselves, if a block is too big or too small they can 'see' and 'feel' in which way it doesn't fit and try others until they are successful. Pupils are able to name the combinations of the blocks that go together to fill the 10-Box and express them orally as equations - Telling the story of 10. They will also understand the concept and language of the missing addend. This becomes a useful strategy when working with subtraction facts not readily internalised. You will find that the language of mathematics is used naturally by children since it fits the facts they have discovered and links their actions with the Structural Arithmetic materials.

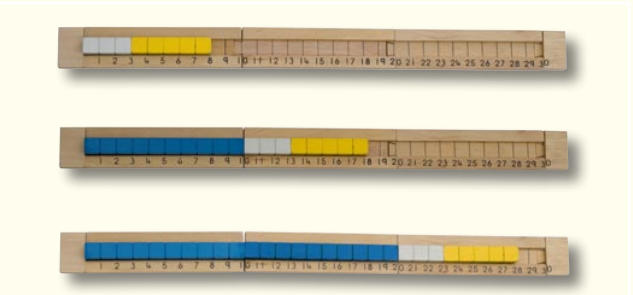
Making sense of numbers

Visualisation skills are crucial in acquiring the fundamental building blocks of maths. Pupils who mostly maintain a ones-based concept do not see numbers as whole ideas. Nor are they able to see that numbers contain many patterns such as the doubles, near doubles or sub-groups. It is also hard for them to see the structures within numbers.

Stern provides opportunities for children to see patterns within numbers. Doubles are seen clearly with the even pattern structure. Near doubles 'neighbours' $3+2$ will also be seen and encourage the strategy double 2, add 1. Addition facts for all numbers can be taught using two different sets of coloured cubes leaving the overall number in view.

Economy of learning – the result of transfer

By making the structure of the number system visual, Stern materials make it possible for children to transfer a newly learned fact to other areas. For instance, if they know that $3+5=8$, they can discover that this fact holds true in any decade by measuring in the Number Track: $13+5=18$, $23+5=28$, or $63+5=68$.



By working with cubes and 10-blocks in the Dual Board, children can see that what is true for the 'ones' as in 3 ones and 5 ones equal 8 ones or $3+5=8$, is also true for the 'tens' as in 3 tens and 5 tens equal 8 tens or $30+50=80$. The result is an immense economy in the number facts that have to be learned. Therefore, it can be seen that Stern is a very appropriate resource to help dyslexic children over-come their surface difficulties with maths and would be an invaluable addition to any classroom.

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A more comprehensive version of this article can be found on www.mathsextra.com

References:

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The Butterworth Dyscalculia Screener published by nferNelson

Dyscalculia Guidance by Brian Butterworth and Dorian Yeo: David Fulton Publishers

For information and advice regarding Dyslexia, Dyscalculia, Dyspraxia contact Jane at Emerson House, London T:0208 741 4554

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