Developing number skills

Teaching children to count and calculate

Professor Sue Buckley OBE
Understanding the number system

• Many children with Down syndrome enjoy numbers but most find them difficult
• There is very little research to draw on
• Early counting and cardinality at MA level (Nye 2001, 2005)
• Few adults achieve calculating to 100 at present
• Language, working memory and knowledge of number facts influence number development in all children
• Effect of cognitive profile?
  – language and verbal STM weak compared with non-verbal skills
  – working memory
Children with Down syndrome (aged 6-14 years at end of study) number skills 4 years behind CA and 2 years behind their reading skills (Byrne, 1997)
Range of skills 11-18 yrs, teenage study data

- More than $\frac{3}{4}$ of young people count to 20,
- About half to 50
- Around $\frac{1}{3}$ read, write, say numbers to 100
- Almost all add amounts up to 10
- More than $\frac{3}{4}$ of young people subtract numbers to 10
- Some add, subtract, multiply, divide for bigger numbers – helped by written sums, apparatus and calculator
- The majority of young people know:
  - days of the week,
  - months of year,
  - tell the time by the hour (half tell by quarter hour)
What can make a difference?

- All studies show that students respond well to good teaching
- Higher attainments by teenagers in mainstream education
- Quality and quantity of education affects learning in both mainstream and special schools
- Italian case studies show higher attainments in teenagers than in group studies
- Suggest our expectations should be higher (E. Monari-Martinez)
Maths tree
Italian teenager working with fractions

\[
\frac{3}{2} \quad \frac{12}{5} \quad \frac{15}{4}
\]

**Riduc. l.m.c.d.**

\[
\begin{align*}
\end{align*}
\]

\[
\text{m.c.d.(2, 5, 12) = 20}
\]

\[
\frac{30}{20} \quad \frac{20}{20} \quad \frac{25}{20} \\
\begin{align*}
\text{.20 : 2} \times 3 &= 60 \\
\Rightarrow 10 \times 3 &= 30
\end{align*}
\]

\[
\begin{align*}
\text{.20 : 5} \times 2 &= 40 \\
\Rightarrow 4 \times 2 &= 8
\end{align*}
\]

\[
\begin{align*}
\text{.20 : 4} \times 5 &= 20 \\
\Rightarrow 5 \times 5 &= 25
\end{align*}
\]

\[
\text{Ratio} \quad \text{R. 13 yrs old}
\]

\[
\text{Sara Stico}
\]
Italian teenagers learn algebra - Martinez

Italian teenagers learn algebra - Martinez

\[ a^2 - 2ab + c^2 = 1 \]
\[ \begin{align*}
1 & = a^2, \quad b = 3, \quad c = -1 \\
2 & = 2ac - 4bc + c^2 = 1 \\
3 & = a - 3bc + 2ac - 7ba = 1 \\
4 & = a^2 - 2ab + c^3 = 1 \\
5 & = 2 \cdot 3 \cdot (-4) + (-2)^3 = 1 \\
6 & = 9 \cdot (-2) + (-2) = 1 \\
7 & = 9 + 30 = 39 = 39 \\
8 & = 2 \cdot 1 \cdot (+2) + (-2) = 1 \\
9 & = 8 \cdot (+2) + 12 \cdot (+2) + (-4) = 1 \\
10 & = 46 + 22 + 4 = 72
\end{align*} \]

D. 16 yrs old
Range of examples growing

• Australian teenagers doing percentages with calculators
• (Rhonda Faragher Barbara Clarke – see chapters on number and maths book on education for pupils with Down syndrome)
• Norway – simple statistics – counting numbers of cars of different colours then plotting a histogram
• Italy – algebra and problem solving with 15 teenagers with Down syndrome published
Teaching students with Down syndrome

- Make full use of visual, practical teaching methods
- Relate to interests, use skills meaningfully in daily life
- Teach language for number – vocabulary (in Dsii number books)
- Discriminate and say number words – this is a challenge for many children due to speech issues
- Learning the number word list (count sequence) is a challenge – use number line for visual support
- More practice at each stage of learning
- Language – research shows gains if the key word is last ‘The ball is red’, ‘Look, balls, there are two’ (Ramscar et al)
Teach vocabulary and basic concepts

Shape and colour words
Circle/square/triangle

- Build with shape bricks, talk about shapes and features
- Size words, big, little
- Order words, first, last, next, before, after
- Comparison words – same, more, different, less
- Big, bigger, biggest – comparatives more difficult
- Pattern and order

Red, blue, yellow

Play matching and sorting games
## A guide to steps in counting and calculating

<table>
<thead>
<tr>
<th>Counting principles</th>
<th>Place value for tens</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1 correspondence</td>
<td>Count to 100 (say, read, write)</td>
</tr>
<tr>
<td>Stable order</td>
<td>Place value to 100</td>
</tr>
<tr>
<td>Cardinality</td>
<td>Add &amp; subtract more than 10</td>
</tr>
<tr>
<td>Order irrelevance</td>
<td>Money – coin values</td>
</tr>
<tr>
<td>Conservation of number</td>
<td>Odd and even numbers</td>
</tr>
<tr>
<td>Addition ‘count-all’</td>
<td>Add &amp; subtract within 100</td>
</tr>
<tr>
<td>Addition ‘counting-on’</td>
<td>Multiplication, division, fractions</td>
</tr>
<tr>
<td>Subtraction 1-10</td>
<td>Partitioning 2 &amp; 3 digit numbers</td>
</tr>
<tr>
<td>Recall number bonds to 10</td>
<td>Target – numbers to 100 for daily life</td>
</tr>
</tbody>
</table>

BUT many teenagers use money and count in daily life without this.
Need to master counting principles

- 1:1 correspondence
  ![1:1 correspondence image]

- Stable order
  ![Stable order image]

- Cardinality
  ![Cardinality image]

- Order irrelevance
  ![Order irrelevance image]

- Conservation of number
  ![Conservation of number image]

- Takes time (5-7 years TD child)
Number is difficult – basics essential

• Learn to say count words
• Learn to use them to count – 1to1 correspondence
• Link numbers with quantity – children can share items and know same or different before they link with counting
• Learn last count word tells you ‘How Many?’
• Understand cardinality – can give correct number from larger set – ‘Give me x’ task is the test
• Equinumerosity - learn same size sets must have same number of objects
• Understand ordinality or succession – each next number is one more
• Move from ‘count all’ to ‘count on’ in addition
• Understand subtraction is inverse of addition
• **Until a child has mastered these concepts for 1-9 cannot move on to place value, numbers above 10 – takes several years**
Activities to teach counting and number

• Use visual support of number line to learn number words in stable order
• Start with learning to say 1-5 but to understand numbers 1-2 then 1,2,3, 1,2,3,4 and 1,2,3,4,5
• Numbers 1,2,3 subitisable (known without counting)
• As children begin to understand numbers = quantity they are ‘1-knowers’, ‘2-knowers’, ‘3-knowers’ then ‘counting principle knowers’ in ‘give x’ task (Sarnecka)
• Play lots of games with objects making sets of 1 and 2, then 1,2,3 and so on – compare ‘same’, ‘more’
• Play **linear** board games (no line 1-5, dice 1,2) (Ramani & Siegler 2009).
Activities to teach number basics

• Play correspondence games with toys/objects to practice one-to-one correspondence
• Play ‘give me’ games and end counting games with ‘How many?’ to teach cardinality
• Play games adding a block, taking away a block to introduce the concepts of adding and subtracting and that they are inverse relationship
• Introduce Numicon – visual-spatial representation of number. Powerful for teaching ‘each next number is one more’, relative sizes of whole numbers, adding……
• NB is not designed to teach basic counting
Extra visual supports for learning number words

- Match, select and name
  - Numerals
  - Numicon shapes
  - Number words
Jago ordering 1-10
Visually support learning number sequences

- Practice different parts of the count sequence
- Rote count from other numbers than 1
Visually support development of cardinality

• With numerals, Numicon shapes, images, objects
Visually support learning about relative sizes 1

- Nesting dolls/pots/cups etc

- Numicon shapes, rods

- With Stern structural arithmetic materials
Skye adding
Jago adding 10+4
Numbers up to 100

- Counting up to 100 with 100 line, square, number cards
- Practice counting in ‘tens’ – understanding position in square, with equipment, tens cards, games to add 10
Similar sounding & similar looking numbers

- Lots of practice with ‘teens’, and ‘ty’s’
  Discriminating, matching, sorting, saying, reading, writing down, matching to images (shapes, rods, Cuisenaire)
  Lotto games
  e.g.17,70, seventeen, seventy
Teach addition with other strategies

- Visually support counting-on with a numeral

  ![Visually support counting-on with a numeral](image)

- Visually support counting-on with a number line

  ![Visually support counting-on with a number line](image)

- With Numicon, spinner

  ![With Numicon, spinner](image)

- Make ‘one more’

  ![Make ‘one more’](image)
Number bonds – learn visual imagery to support Strategies for subtraction, taking away

- ‘Taking away’, ‘Counting-back, ‘difference’ (counting forward) using a number line
- ‘Chopping –off’ using Numicon
- Recall of number facts, doubles
- Number sentences/stories
Ben – 2 times tables
Place value – tens and units

• Stern dual board
• For units and tens

(Wave 3 resources cards)
Wider maths curriculum

Draw one straight line to cut each shape into two equal parts. Your line must pass through the dot. Write $\frac{1}{2}$ on each part. Colour each half a different colour.

Plot the following:

- Church ⬠ 01, A
- School ⬠ 03, C
- Pond ⬠ 06, F
- Telephone ⬠ 04, I
- Golf course ⬠ 04, E
- Footpath ⬠ 05, G
- Lighthouse ⬠ 07, A
- Car park ⬠ 09, B

Daniel was able to plot objects in correct place with some help.
Revision, practice

Measure my lines

Date 15/11/2015

Th. H. T. U. subtraction

7 4 13 1
- 3 2 5
4 1 0 9

Exchange numbers

What's double 3 4 double 1 2 double 2 4

Counting on in your head

4 5 3 4 6

Halve the numbers

1/2 of 10 = 5 1/2 of 2 = 1 1/2 of 6 = 3 1/2 of 8 = 4

Put these numbers in the correct order: start with the lowest

10 14 18 6 15 2 20

Division using cubes

14 ÷ 2 = 7 34 ÷ 3 = 11 56 ÷ 4 = 14

Write the numbers

Thirty four: 3 4

Six hundred and two: 6 0 2
Summary

• Number challenges most students with Down syndrome
• Students will need supports for measurement, arithmetic, mental calculations and problem solving
• Visual parts of the maths curriculum are more accessible
• For example, shape, geometry, fractions, algebra, diagrams, graphs
• Need for extra resources

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See and Learn Number

- First Counting – teaches number words, numerals, counting, cardinality and equivalence 1-10 – in small steps
- First Concepts – teaches colours, size, shape, categories, ordering, sequences 1-10
- First Sums – teaches ordinality, inversion, relative sizes of numbers, addition, subtraction, multiplication 1-10
- Kits and apps
Resources and references

- Numicon teaching kits:
  - 1st Steps with Numicon at Home is a starter kit for parents
  - Numicon Firm Foundations Kits – One-to-one and Class Kits
  - See whole Numicon range at our online store
- Horstemeier, D. (Books 1 & 2) Teaching math to people with Down syndrome and other hands-on-learners. Woodbine House
- Articles on number (Buckley et al.) and case studies - see http://www.down-syndrome.org/research-practice/12/1/
Additional resources

• Numbershark CD and other teaching materials - http://www.parentscanteach.co.uk/
• Range of software from Inclusive technology, http://www.inclusive.co.uk
• Time cracker Quality in Education Centre, Strathclyde University www.strath.ac.uk/qie
• See and Learn Number – developing See and Learn kits and apps to teach first maths concepts (size, shape, colour, pattern) and first counting (to adding and subtracting 1-9) - coming 2014
• Buckley, S., Bird, G. Memory Development for individuals with Down syndrome. Down Syndrome Issues and Information
  http://www.down-syndrome.org/information/memory/overview/
• Bird, G & Buckley, S. Number skills for children with Down syndrome 5-11, 11-16 years. Down Syndrome Issues and Information
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• Brigstocke, S., Hulme, C. & Nye, J. Number and arithmetic skills in children with Down syndrome.
  • http://www.down-syndrome.org/reviews/2070/

• University of York website about memory – for parents and teachers
  • http://www.york.ac.uk/res/wml/indexteachers.htm


• Ramscar, M. Dye, M et al. (2011) The enigma of number: Why children find the meanings of even small number words hard to learn and how we can help them do better. PLoS one 6 (7) e222501.