



Teaching Early Numeracy to Children with Developmental Disabilities



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Dr Corinna Grindle

11th Special Education Day, 10th March, 2021

Autism, participation and learning focus on preschool and school

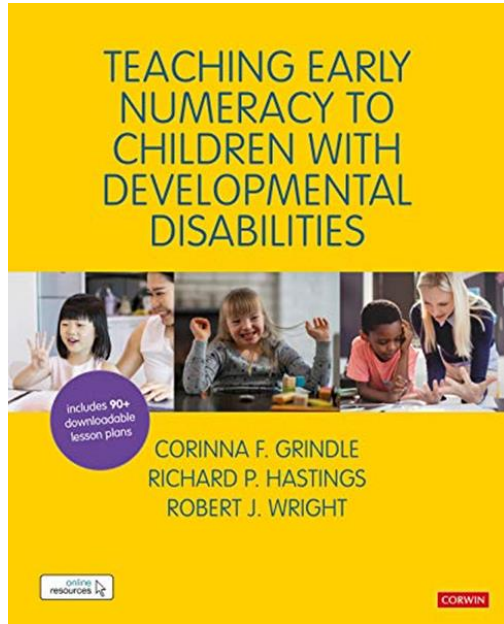
Overview of today's session

- What is *Teaching Early Numeracy to Children with Developmental Disabilities (TEN-DD)*?
- How do we know that TEN-DD is effective?
- How will TEN-DD benefit children that you work with?

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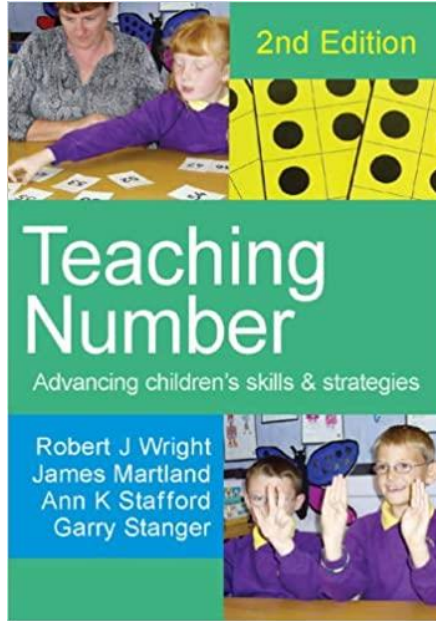


What is TEN-DD?



- Evidence- based numeracy curriculum for children with developmental disabilities
- Published in a comprehensive practical guide, available on Amazon
- Book sets out key principles of teaching and learning
- Introductory context- chapters 1 to 3, I will be covering today.
- Book comes with a comprehensive set of online resources, including 90+ lesson plans
- Teachers and teaching assistants can be trained to deliver the principles described in the book

What is TEN-DD?



- TEN-DD is based on **Maths Recovery**
- This was developed initially for low attaining typically developing children (6-7 year olds)
- The curriculum is divided into **five developmental stages** with progressive levels of sophistication

Developmental Stage	Typical skills of a child at this stage
Emergent	The child has some simple rote counting skills, but few numerical skills. That is, they either do not know number words or cannot coordinate the number words with items.
Perceptual	The child can count objects when they can see, hear and feel items and sometimes add small sets of objects that are present.
Figurative	The child can count well and use “counting-all” strategies to add. That is, they are able to count to find out the total number of objects in two separate collections. They can also do some simple subtraction tasks.
Counting On	This stage is at or above the average for most year 2 typically developing children (age 6-7). The child can add by “counting on from the larger number” and subtract by counting down; they can read numerals up to 100 but have little understanding of place value.
Facile	The child has developed a wide range of strategies other than counting in ones. They know some number facts; is able to use some derived fact strategies; can multiply and divide by strategies based on repeated addition; may have difficulty with carrying and borrowing.

Related Key Topics for the EMERGENT stage	Focus
Number word sequences from 1 to 20	Knowledge of forward number word sequences in the range 1 to 20 and backward number word sequences in the range 1 to 10
Numerals from 1 to 20	Knowledge of numerals in the range 1 to 20 .
Counting visible items (objects)	Perceptual counting strategies
Spatial patterns	Ascribing number to spatial patterns and random arrays. For example, counting and recognizing dots arranged in domino patterns and in random arrays.
Finger patterns	Recognizing, demonstrating and manipulating finger patterns for quantities up to 5.
Temporal patterns and temporal sequences	Copying and counting temporal patterns and temporal sequences. For example, counting sounds or movements that take place in a sequence



Teaching Activities within Each Key Topic:

Emergent stage- Number Word Sequences from 1-20

1. Short forward number word sequences
2. Short backward number word sequences
3. Saying alternate number word forwards
4. Saying alternate number words backwards
5. Saying the next number word forwards
6. Saying the next number word backwards
7. Saying the number word after
8. Saying the number word before

Numeracy Targets Organised:

Horizontally - different groups of activities within the same ability level – key topics

- Vertically - within each key topic there are progressive stages of difficulty.
- Emergent stage- 32 teaching activities
- Perceptual stage- 30 teaching activities
- Figurative stage- 42 teaching activities
- Counting on stage- 42 teaching activities
- Facile stage- 33 teaching activities

179 teaching activities

Theoretical Basis for Maths Recovery

- Constructivist methodology (see p, 27-28)
 - Very child led
 - Children expected to problem solve and come up with their own solutions and to provide rationale for their answers
 - Requires a high level of critical or abstract skills
- How suitable is this style of teaching for children with a developmental disability?

The Key Debate

- The debate hinges on the extent to which students require structure and supports from their teacher to learn new skills
- Instructional approaches can be put on a continuum
 - **Constructivist approach**- when less guidance is needed
 - **Systematic Instruction**- when more guidance is needed

What does the research tell us?

- Systematic Review evidence
 - Browder et al (2008)
 - Spooner et al (2019)
- Teaching approach associated with best outcomes is:
 - **Systematic Instruction**



Why might Maths Recovery be suitable to adapt?

- It is an evidenced based approach
- It offers a comprehensive approach
- It can be used with students who have yet to acquire any numeracy skills
- It involves an individualized teaching approach
- It has many elements consistent with systematic instruction (e.g., micro adjusting and scaffolding)

Adaptations

1. “What” to teach

- - the curriculum/ lesson plans

• 2. “How” to teach

- - pedagogy/ teaching strategies

Adaptations to the lesson plans

- Task analysis of difficult to teach skills- smaller steps
- Short, succinct verbal instructions
- Prompting and prompt fading suggestions
- Mastery criterion
- Generalisation strategies
-and written in an accessible format for teachers and teaching assistants

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Stage A

EMERGENT LESSON
PLANS

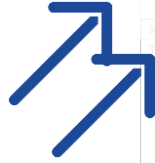
Corinna Grindle, Magda Iena Apanasionok, Beverley
Jones, Pagona Tzanakaki

The development of the lesson plans was supported by The Sharland Foundation Developmental Disabilities ABA Research and Impact Network (SF-DDARIN).

Structure of the Lesson Plans

Each lesson plan has six key sections:

- Target specification and learning objective
- Materials
- Teaching procedure



A1: Key Topic: Number Word Sequences from 1 to 20	
Target: A1.1	Purpose: To develop knowledge of forward number word sequences in the range 1 to 20
<i>Copying and Saying Short Forward Number Word Sequences (FNWS)</i>	
Materials	None
Teaching Procedure	<p>Check that the student is ready to learn (looking at the teacher, sitting up straight, etc).</p> <p>Step one- Copying For saying FNWSs with a modelling prompt. Teacher: "Let's count: 1, 2, 3. Now your turn" Student: Repeats: "1, 2, 3". Reinforce the response.</p> <p>Once mastered, continue the procedure with:</p> <ul style="list-style-type: none">• 4 to 6• 7 to 10 <p>Step two- Saying For saying FNWSs without a modelling prompt. Teacher: "Count from one up to five." Student: Says "1-2-3-4-5". Reinforce the response.</p> <p>Once mastered, continue the procedure with:</p> <ul style="list-style-type: none">• 4 to 6• 7 to 10 <p>The student should respond within 3 seconds after the instruction has been given and say the correct number sequence. If not, please refer to: Help that may be provided.</p>
Generalisation plan	<ul style="list-style-type: none">• At home teacher asks the student to complete the task.• Use different instructions - e.g. "Copy now 1-2-3"• Teach in a different setting or at a different time of the day.
Help that may be provided	<ul style="list-style-type: none">• If the student omits a number (e.g. says 1, 2, 3, 5), the next time the sequence is presented say the omitted number in a very loud voice. (e.g. 1, 2, 3, 4 loudly, 5)• If the error continues, repeat 1-2-3-3-3 and/or forward (for example, start on 4, 5 and count on: then on 6, 6, 6, then on 2, 3, 3, 3 etc.• If the student continues counting on (e.g. says 1, 2, 3, 4, 5, 6...), for "count on to 5" put up your hand to indicate when the student should stop. Alternatively, show a number card (e.g. card with the number 5) to remind them when to stop.• Each step can be introduced initially with shorter number word sequences (e.g. with 2 numbers), gradually building up to the longer sequences (e.g. 5 numbers).• If the student has difficulty pronouncing thirteen, fourteen, fifteen etc. do some separate work where you practice speaking on articulation, emphasising the part of the word they are struggling with, e.g. say, thirteen
Prerequisite(s)	Three tasks in a row across 3 consecutive days.

Structure of the Lesson Plans

Each lesson plan has six key sections:

- Target specification and learning objective
- Materials
- Teaching procedure
- Generalisation plan
- Help that may be provided
- Mastering criterion



A1: Key Topic: Number Word Sequences from 1 to 20	
Target: A1.1	Purpose: To develop knowledge of forward number word sequences in the range 1 to 20.
Copying and Saying Short Forward Number Word Sequences (FNWS)	
Materials	None
Teaching procedure	<p>Check that the student is ready to learn (looking at the teacher, sitting up straight, etc).</p> <p>Step one: Copying For saying 1FNWS with a modelling prompt. Teacher: Copy me: 1, 2, 3, 4, 5 (loud and clear) Student: Repetes: 1, 2, 3, 4, 5. Reinforce the response.</p> <p>Once mastered, continue the procedure with: • 4 to 5 • 7 to 10</p> <p>Step two: Saying For saying 1FNWS without modelling prompt. Teacher: Repeat from memory please! Student: Says: 1-1-2-4-5 Reinforce the response.</p> <p>Once mastered, continue the procedure with: • 4 to 5 • 7 to 10</p> <p>The student should respond within 3 seconds after the instruction has been given and say the correct number sequence. If not, please refer to help that may be provided.</p>
Generalisation plan	<ul style="list-style-type: none">• Another teacher asks the student to complete the task.• Use different instructions – e.g. "Copy me: 1-2-3".• Teach in a different setting or at a different time of the day.
Help that may be provided	<ul style="list-style-type: none">• If the student omits a number (e.g. says 1, 2, 3, 5), the next time the sequence is modelled say the omitted number in a very loud voice, e.g. 1, 2, 3, 4 (loud), 5.• If the error continues, count backward and/or forward for example, work on 4, 5 until consistent, then on 3, 4, 5, then on 2, 3, 4, 5 etc.• If the student continues counting on (e.g. says 1, 2, 3, 4, 5, 6... for "count up to 5") put up your hand to indicate when the student should stop. Alternatively, show a number card (e.g., card with the number 5) to remind them when to stop.• Each step can be introduced initially with shorter number word sequences (e.g., with 2 numbers), gradually building up to the longer sequences (e.g., 5 numbers).• If the student has difficulty pronouncing thirteen, fourteen, fifteen etc, do some separate work where you practice working on articulation, emphasising the part of the word they are struggling with, e.g., say, <u>thir</u>teen
Mastering criterion	Three ticks (✓) in a row across 3 consecutive days.

Adaptations to the teaching practices

- Assessment interview replaced with probe tests
- Specification on strategies for how to increase motivation for learning
- Emphasis on repeated practice through using systematic instruction teaching procedures
- Fast paced sessions with monitoring (data collection) and feedback (e.g., error correction)

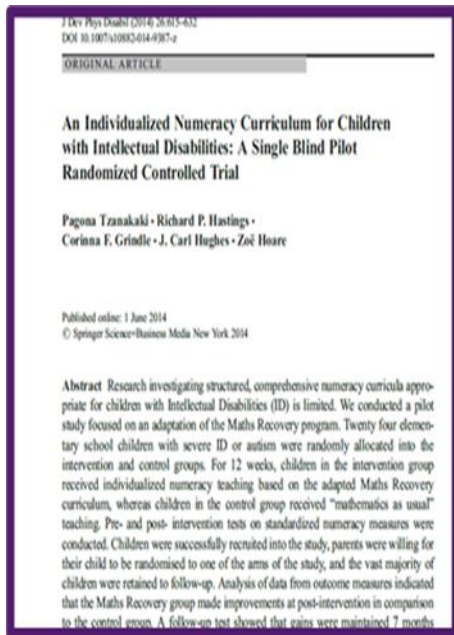


How may TEN-DD benefit children you work with?

- Improving numeracy attainment
- Enabling access to other areas of the curriculum and functional living skills
- Promoting the use of evidence-based interventions and raising standards in mathematics
- Promoting high quality, cost effective, individualized and small group instruction to children with autism and learning difficulties



Publications



Tzanakaki, P., Grindle, C. F., Saville, M., Hastings, R. P., Hughes, J. C., & Huxley, K. (2014). An individualized curriculum to teach numeracy skills to children with autism: program description and pilot data. *Support for Learning*, **29**, 319-338.

Tzanakaki, P., Grindle, C. F., Saville, M., Hastings, R. P., Hughes, J. C., & Huxley, K. (2014). An individualized curriculum to teach numeracy skills to children with autism: program description and pilot data. *Support for Learning*, **29**, 319-338

Tryggestad H., & Eldevik, S. (2016). Effekter av et Atferdsanalytisk Basert Program for Elever med Matematikkvanser; Et Pilotprosjekt [Effects of a behavioural analytic based program for students with mathematical difficulties: A pilot project]. *Norwegian Journal of Behavioural Analysis/ Norsk Tidsskrift for Atferdsanalyse*, **43, 181-197.**

Apanasionok, M., Alalawi, B., Grindle, C. F., & Hastings, R. P., Watkins, R. C., Nicholls, G., Maguire, L., Staunton, D. (2021). Teaching Early Numeracy to Students with Autism Using a Teacher Delivery Model. *British Journal of Special Education*. Advance online publication.

Alalawi, B., Hastings, R. P., & Grindle, C. F. (under review). Parent mediated numeracy intervention for children with Autism Spectrum Disorder in Arabic families living in the UK. *Support for Learning*.

Alalawi, B., Denne, L., Apanasionok, M., Grindle, C. F., & Hastings, R. P. (under review). Special Educators' Experiences of a Numeracy Intervention for Students with Autism Spectrum Disorder. *Focus on Autism and Other Developmental Disorders*.

An individualised curriculum to teach numeracy skills to children with autism: programme description and pilot data

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CORINNA FAY GRINDLE, MARIA SAVILLE,
RICHARD PATRICK HASTINGS,
JOHN CARL HUGHES and
KATHLEEN HUXLEY

Teaching mathematics to children with autism is an area with limited research evidence. In this study we developed a teaching manual based on Maths Recovery, a numeracy programme designed for typically developing children. Six children with autism participated in the study and received daily numeracy teaching over a 20-week period. Our aims were to explore whether Maths Recovery can be used as a numeracy curriculum for children with autism and to evaluate the progress the children make after a period of intensive teaching. Using a pre-test post-test design we found that the adapted Maths Recovery numeracy curriculum was successfully incorporated within each child's individualised teaching programme, and that all six children improved their mathematical ability over the course of the intervention. Our data show promising results and support the rationale for larger evaluation studies.

Key words: autism, mathematics, numeracy curriculum.

J Dev Phys Disabil (2014) 26:315–332
DOI 10.1007/s10822-014-9387-z

ORIGINAL ARTICLE

An Individualized Numeracy Curriculum for Children with Intellectual Disabilities: A Single Blind Pilot Randomized Controlled Trial

Pagona Tzanakaki · Richard P. Hastings ·
Corinna F. Grindle · J. Carl Hughes · Zoi Hoare

Published online: 1 June 2014
© Springer Science+Business Media New York 2014

Abstract Research investigating structured, comprehensive numeracy curricula appropriate for children with Intellectual Disabilities (ID) is limited. We conducted a pilot study focused on an adaptation of the Maths Recovery program. Twenty four elementary school children with severe ID or autism were randomly allocated into the intervention and control groups. For 12 weeks, children in the intervention group received individualized numeracy teaching based on the adapted Maths Recovery curriculum, whereas children in the control group received “mathematics as usual” teaching. Pre- and post-intervention tests on standardized numeracy measures were conducted. Children were successfully recruited into the study, parents were willing for their child to be randomised to one of the arms of the study, and the vast majority of children were retained to follow-up. Analysis of data from outcome measures indicated that the Maths Recovery group made improvements at post-intervention in comparison to the control group. A follow-up test showed that gains were maintained 7 months

How do we know that TEN-DD is effective?

- Research programme at the Centre for Educational Development, Appraisal and Research (CEDAR) spanning more than a decade
- Effective with young children as “first” numeracy programme
- Effective with older children as “catch up” numeracy programme
- Can be delivered one-to-one or in small groups

Which Children will Benefit from TEN-DD?

- Those children struggling to learn numeracy using the schools' typical methods
- Primary and secondary school pupils
- Attending special or mainstream school settings
- Certain prerequisite skills required for maximal benefit, including imitation (so that modeling prompts can be used)



Charlotte Madine, Chair, Mathematics Recovery Council UK & Ireland

“This very useful book adapts the Maths Recovery Programme to suit the learning needs of students with a developmental disability. It provides an extensive and detailed approach to assessment, learning and teaching that embodies evidence-based best practice”.



Professor Adam Boddison, Chief Executive of the National Association for Special Educational Needs (NASEN)

“This much needed book is an essential read not only for educators but for educational leaders everywhere..... This book is a vital tool in maximising the numeracy potential of all children and I wish somebody had given this to me when I became a maths teacher more than 15 years ago”.



**THANKS FOR
LISTENING!
IT'S
TIME FOR
QUESTIONS!**

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