Design and use of an assessment to observe emergent numeracy skills in young children with additional needs

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Intention of this presentation

• Introduce the ABLES/SWANs assessment program
• Explain the steps followed to develop a numeracy assessment for use with students with disability
• Give you time to plan for student learning using the numeracy progression
• Reflect on use of the progression to inform your planning
Introducing the ABLES/SWANs assessment program
Design principles for developmental assessment

- Track progress of student each
- Draw on teacher judgement
- Enable consistent language of student learning
- Give information to support instruction
- Focus on the skills and abilities of each student
- Enable reporting of student progress on a continuum
Introducing SWANs/ABLES

- SWANs/ABLES is an online assessment program
  SWANs (Students with additional needs) and ABLES (Abilities Based Learning Education Support)
- It draws on teacher observation of student behaviour/skills in the classroom setting
- There are nine assessments aimed to describe foundational skills
- Assessments are appropriate for students regardless of age, year level or setting
The ABLES portal

The options

Select from the options below
- Register Students
- Assign Classes
- Assess Students
- Produce Reports
- View Student Records
- Guidance Materials
- Change Password
- Exit

The nine assessments

Select from any of the following assessments
- English, Speaking and Listening
- English, Reading and Writing
- Personal and Social Capability
- Mathematics
- Movement
- Digital Literacy
- Critical and Creative Thinking
- Self Awareness: Emotion
- Self Awareness: Self
- Social Awareness
- Main Menu
Each assessment includes:

A list of teaching strategies (matched to student level)

A set of assessment items (written as observations) that assess every student

A learning report (describing student level)
How is it suited to you in your context?

• The assessments describe approximately four learning levels prior to Foundation (e.g., A-D of Victorian Curriculum)
• Most assessments reach into Level 2 or 3 of the Victorian Curriculum
• The assessments were trialled with students with disabilities, and therefore are ‘validated’ for this population
• However, teachers sometimes choose to use the assessment for student who ‘sit outside the expected range’ for their age or grade
Explaining the steps followed to develop the numeracy ABLES assessment
The numeracy assessment aimed to measure student ability to “Use symbolic representation of quantity, shape and pattern to bring order to the world”

- **Using phenomena** — applying rules and operations to bring order to the world
- **Describing phenomena** by language and symbol to establish shared meaning of the world
- **Noticing phenomena** — quantity, shape and pattern in the world
## Documents that informed the instrument

<table>
<thead>
<tr>
<th>Document</th>
<th>Relevant content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Curriculum</td>
<td>Numeracy general capability</td>
</tr>
<tr>
<td>(Australian Curriculum and Assessment Authority, 2017)</td>
<td>Mathematics learning area</td>
</tr>
<tr>
<td>Victorian Curriculum</td>
<td>Mathematics Level A-3</td>
</tr>
<tr>
<td>(Victorian Curriculum and Assessment Authority, 2017)</td>
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</tr>
<tr>
<td>Mathematics Learning Pathways for Children from Birth to Five years</td>
<td>Individual skills described in developmental sequence</td>
</tr>
<tr>
<td>(Department of Education and Early Childhood Development, 2014)</td>
<td>Typically developing children from birth to five.</td>
</tr>
<tr>
<td>Learning Trajectories Approach and RMA Real Maths Building Blocks Curriculum</td>
<td>Individual skills designed from empirical studies of typically developing children from birth to five years</td>
</tr>
</tbody>
</table>
Design and trial of the instrument

Steps proposed by Wolfe and Smith (2007a, 2007b)

1. Review the purpose of the measure and define the construct
   - Review the literature and curriculum documents

2. Draft a pool of items with subject matter experts
   - Conduct workshops with teachers of numeracy to students disability to write items

3. Panel/revise the items
   - Review of items by experienced assessment writers

4. Pilot the items with intended users
   - Review of items by intended users

5. Trial items in schools
   - Trial of items in schools

6. Analyse data and calibrate to identify the learning progression
   - Use Rasch (1980) analysis to review the statistical properties and calibrate the measure
## Writing and reviewing the pool of items

<table>
<thead>
<tr>
<th>Research activity</th>
<th>No. of participants</th>
<th>Expertise of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workshop 1</strong> Define/review the construct of emergent numeracy</td>
<td>7</td>
<td>Developmental psychologists from the area of numeracy</td>
</tr>
<tr>
<td><strong>Workshop 2</strong> Review construct and define capabilities</td>
<td>17</td>
<td>Teachers experienced in numeracy instruction for students with disability</td>
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<tr>
<td><strong>Workshop 3</strong> Write performance criteria and hypothesise difficulty</td>
<td>16</td>
<td>Teachers experienced in numeracy instruction for students with disability</td>
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<tr>
<td>Panelling the items</td>
<td>7</td>
<td>Experienced assessment developers, psychometrician, numeracy expert, three doctoral researchers</td>
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<tr>
<td>Piloting the items in schools with intended users</td>
<td>16</td>
<td>Teachers of numeracy to students with disability in two schools</td>
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</tbody>
</table>
An example item

INSTRUCTIONS: For each question, please choose ONLY ONE response. The response you choose should be the closest match to this student’s typical performance. If you feel the student performance falls between two levels, select the lower one. This will indicate that the student has achieved that level but has not reached the higher one.

Q1. Counting using number words (e.g., one, two, three, four)

Noticing
Attends to counting by another person (e.g., looks, listens, turns towards)

Describing
Connects number words to up to three objects (e.g., says or signs numbers up to three whilst touching or looking at each object)

Using
Counts to find the total when asked ‘how many?’ for four or more objects
Is moving towards but has not yet achieved these skills/behaviours
23 numeracy items

• Counting using number words
• Retaining the number of objects
• Recognising quantities
• Ordering numerals
• Dividing an object
• Diving a collection of objects
• Describing a change in quantity
• Adding items to a group
• Subtracting items from a group
• Skip counting
• Differentiating common 2D shapes
• Completing written number patterns

• Comparing length of common objects
• Comparing the size of common objects
• Sorting objects into categories
• Describing relative position
• Recognising and making patterns
• Using ordinal number
• Predicting outcome of events
• Interpreting representations of information
• Working with concepts of time/duration
• Identifying/naming Australian coins
• Working with place value
## Schools that participated in the trial

<table>
<thead>
<tr>
<th>Type of school</th>
<th>Number of schools</th>
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<tbody>
<tr>
<td>Special schools</td>
<td>15</td>
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<td>Specialist schools</td>
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<td>Special developmental schools</td>
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<td>Mainstream schools</td>
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<td>Schools for students with physical impairments</td>
<td>4</td>
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<td>Schools for students with Autism Spectrum Disorder</td>
<td>5</td>
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<tr>
<td>Schools for students who are deaf or hard of hearing</td>
<td>1</td>
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Students that participated in the trial

<table>
<thead>
<tr>
<th>Represented students</th>
<th>Special settings 96%</th>
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<tbody>
<tr>
<td></td>
<td>Mainstream 4%</td>
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<tr>
<td>Gender</td>
<td>70% male</td>
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<td>30% female</td>
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<tr>
<td>Autism spectrum disorder</td>
<td>49%</td>
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<td>Physical Disability</td>
<td>20%</td>
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<tr>
<td>Vision impairment</td>
<td>8%</td>
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<td>Severe behavior disorder</td>
<td>7%</td>
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<td>Hearing impairment</td>
<td>5%</td>
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<tr>
<td>Intellectual disability</td>
<td>72%</td>
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<td>Severe language disorder with critical educational needs</td>
<td>25%</td>
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### Wright map and reliability statistics

Person separation reliability 0.99

Item separation reliability 1.0

Cronbach’s Alpha coefficient 0.98

Item fit range 0.71 – 1.31

<table>
<thead>
<tr>
<th>Wright Map</th>
<th>Person Separation Reliability</th>
<th>Item Separation Reliability</th>
<th>Cronbach’s Alpha Coefficient</th>
<th>Item Fit Range</th>
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Planning learning for a student using the materials
Learning progression and Rocket report

Pathways of emergent numeracy development for students with additional needs

8. Learning to apply mathematical operations for precise manipulation of numbers

The student is beginning to apply mathematical operations such as division, and to describe the outcomes using mathematical language such as ‘half the group’ or ‘quarter of a cup’. The student may use skip counting in everyday activities and can explain his/her purpose. The student is beginning to create and outline patterns using different objects that can be used to create designs or to solve problems. The student is learning to work with large numbers, and may demonstrate understanding of place value by explaining the value of each numeral in four-digit numbers. The student is starting to apply mathematical strategies, such as addition and subtraction, to solve and explain number patterns, and use measuring tapes or rulers to accurately measure length and explain his/her findings.

9. Learning to count and apply number concepts in order, compare, connect, and measure events and objects

The student is beginning to demonstrate an understanding of how numbers can be applied to abstract concepts such as ordering and comparing events and objects. An understanding of order may be demonstrated by placing Australian money in relative order or by explaining a sequence of events using ordinal number. The student is learning the language of time and may refer to the duration of activities using units such as minutes, hours and days. The student is learning the language of time and may demonstrate his/her understanding of the relative duration of events and may demonstrate this by applying rules (e.g., same shape or colour) to organise objects into various categories and explain his/her classifications. Students at this level are developing an understanding of measurement and the ability to demonstrate this by using informal measures to compare length. The student is beginning to identify Australian coins and bills by their value names.

10. Learning to count up to 20 and build and describe a vocabulary to describe simple numerical concepts

The student is learning to count forwards and backwards from 1 to 20. The student is beginning to recognise patterns, developing an ability to read and write numbers, and is developing an understanding of the quantity of a group. The student may demonstrate understanding of number conservation by explaining that the total number of objects does not change when their position is rearranged. The student is developing the language to describe the placement of an object using terms such as left, right, top and bottom and can identify and describe familiar 2D shapes they see in their environment. The student is learning to respond to instructions such as being asked to take away or add an item.

11. Learning the language of number, shape and relationships

The student is learning to consistently attach number words to objects to find the total of a group. The student is developing the ability to order numbers from 0 to 10 and to indicate the total of a collection of 1 to 3 objects without counting (subitising). In working with quantity, the student is beginning to demonstrate strategies (other than recount) to find the total when working with changes of quantity, and is developing the ability to accurately record three digit numbers that are read or spoken to him/her.

12. Learning to classify shapes and objects into groups and work with numbers up to 100

The student is beginning to demonstrate an understanding of how numbers can be applied to abstract concepts such as ordering and comparing events and objects. An understanding of order may be demonstrated by placing objects in a familiar environment, and may demonstrate understanding of another concept by explaining that the total number of objects does not change when their position is rearranged. The student is learning the language of time and may refer to the duration of activities using units such as minutes, hours and days. The student is learning the language of time and may demonstrate his/her understanding of the relative duration of events and may demonstrate this by using informal measures to compare length. The student is beginning to identify Australian coins and bills by their value names.

13. Learning to represent numbers to 100, which may be demonstrated by placing written or printed two-digit numbers in ascending order. The student may compare objects in rows, two at a time. The student may demonstrate understanding of another concept by explaining that the total number of objects does not change when their position is rearranged. The student is developing the language to describe the placement of an object using terms such as left, right, top and bottom and can identify and describe familiar 2D shapes they see in their environment. The student is learning to respond to instructions such as being asked to take away or add an item.

14. Learning to use number words to count and to identify different magnitudes

The student is learning to consistently attach number words to objects to find the total of a group. The student is developing the ability to order numbers from 0 to 10 and to indicate the total of a collection of 1 to 3 objects without counting (subitising). In working with quantity, the student is beginning to count in order to check the quantity of a group of concrete materials if objects have been added or removed. The student is starting to use language to describe concepts such as shape and form. For example, the student may comment on an event right or might find an event occurs when asked or following a demonstration. The student is beginning to develop an understanding of how numbers can be applied to abstract concepts such as ordering and comparing events and objects. An understanding of order may be demonstrated by placing objects in a familiar environment, and may demonstrate understanding of another concept by explaining that the total number of objects does not change when their position is rearranged. The student is learning the language of time and may refer to the duration of activities using units such as minutes, hours and days. The student is learning the language of time and may demonstrate his/her understanding of the relative duration of events and may demonstrate this by using informal measures to compare length. The student is beginning to identify Australian coins and bills by their value names.

15. Learning the language of numeracy, shape and relationships

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Example case study

Joshua

Joshua, who is 12 years old, attends a school for students who are deaf or hard of hearing. He has an intellectual disability, which has made it difficult for him to establish the foundations of literacy and numeracy skills. His teacher has assessed him as working at Level 2 on the Mathematics progression. His records show that Joshua recognises a representation of up to three objects and can place the numerals 1 to 5 in order with support and prompting. He watches, and sometimes comments, when an object or collection of objects is divided into parts, and adds an extra item to a collection when asked. He can point to different shapes (e.g., a circle or square) when they are shown to him in a classroom activity, and he enjoys exploring objects of different size and shape. He notices when objects have been moved, although he does not yet have the words to describe their position in relation to each other, and he responds to changes in the classroom such as a new person entering the room or a new activity being placed before him.

Participants are given one case study

It described the skills achieved by a student on the numeracy items, and their level, and disability

The student age was altered, and a name invented
ILP template to complete

Work in pairs to write an ILP

Use the case study to establish the student’s current skills, or *entry skills*

Use the progression to identify a *long term goal/s*, and shorter term *outcome targets*

Describe *teaching strategies* you would use to scaffold the student’s learning
Reflecting on using the materials to plan for student learning

About you:
What is your current role (e.g., teacher, leadership, student etc.)
Have you used ABLES in a school before?
Have you used SWANs in a school before?

Drawing on your activities today:
Could you place this case study student into a level on the progression (the blue sheet)?
Why/why not?

How easy/difficult was it to complete the section on:
Long term goal:
Enter skills:
Outcome targets/short term goals:
How easy/difficult was it to write teaching strategies matched to this student and their needs?

Suggesting improvements:
What changes would you suggest to make this progression more useful? (e.g., presented differently, separated into strands, interactive report, linked to reports from multiple assessments etc.)

What additional materials would support you to target your teaching of the skills described in the progression?
Thank you!
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