



MELBOURNE GRADUATE
SCHOOL OF EDUCATION



Department of
Education & Training

Every student can learn maths: Recognising core numeracy skills in students with diverse additional learning needs

Thursday 9th June, 2016

Jane Strickland



Learner at the centre

- All students have a right to high quality education
- Quality education requires highly skilled teachers to suit the individual and diverse learning needs of students
- High quality assessment helps teachers identify the existing skills of students
- Assessments that develop a continuum of skills assist teachers to identify the content that a student might be ready to learn next



Why is maths so important?

- Numeracy is defined by OECD (2012) as 'ability to access, use, interpret, and communicate mathematical information and ideas, to engage in and manage mathematical demands of a range of situations in adult life'
- Children have innate number abilities (Izard et al, 2009) and build on these to construct mathematical ideas through cognitive development and interaction with their environment (Geist, 2010)
- Poor numeracy is associated with a negative impact on an individual's chance of school completion (Parsons & Bynner, 1995)
- Longitudinal research found individuals with poor numeracy are less likely to own their own home, have a higher risk of depression and if employed are more likely to be in semi-skilled or unskilled jobs (Bynner and Parsons, 2005)



The challenges in schools

- One in 20 students receive additional funding through the Program for Students with Disabilities, but a further one in five students require adjustments to their learning (Victorian Auditor-General, 2012)
- Teachers feel a lack of support for teaching students with additional needs (VEOHRC, 2012)
- 11 years after the introduction of the 2005 Disability Standards for Education (Cth), students with additional needs are not being provided adequate instruction and access to learning (Senate Committee, 2016; Victorian Equal Opportunity & Human Rights Commission, 2012)

Assessing via NAPLAN

2.1 NAPLAN is a national assessment, and all students are expected to participate. NAPLAN should be accessible to all students to demonstrate their actual skills and knowledge.

Disability adjustments should be granted that are appropriate for students to access and participate in the tests.

- Adjustments should not compromise the ability to assess the underlying skills that are the objects of the assessments, as outlined in Section 6.2.3.

- 1.8% of Australian grade 3 students were exempt from the NAPLAN numeracy test in 2015

- 3.7% of Australian grade 3 students did not meet the national minimum standard in the NAPLAN numeracy test in 2015

How is the learning of these 5.5% of Victorian students measured?

Measuring the learning of students who are exempt

- Presently no empirically validated numeracy assessments designed specifically for students with additional learning needs are available
- Assessments designed for students with additional needs often feature long checklists, can be time consuming and don't help teachers know the content to teach next
- Assessments that start at foundation level do not always cater for students with additional needs. They may not allow these students to demonstrate what they know and can do.



Quality assessment

- Well designed assessments direct teacher attention to the important skills and measure them consistently
- Judgement-based methods of assessment capitalise on teachers' experience and knowledge of their students to accurately observe students with additional needs (Woods, 2014)
- Framing teacher judgement within a criterion-referenced framework (Griffin, 2014) allows teachers to view student progress against a continuum rather than make unhelpful comparisons to typically developing students



Learning progressions

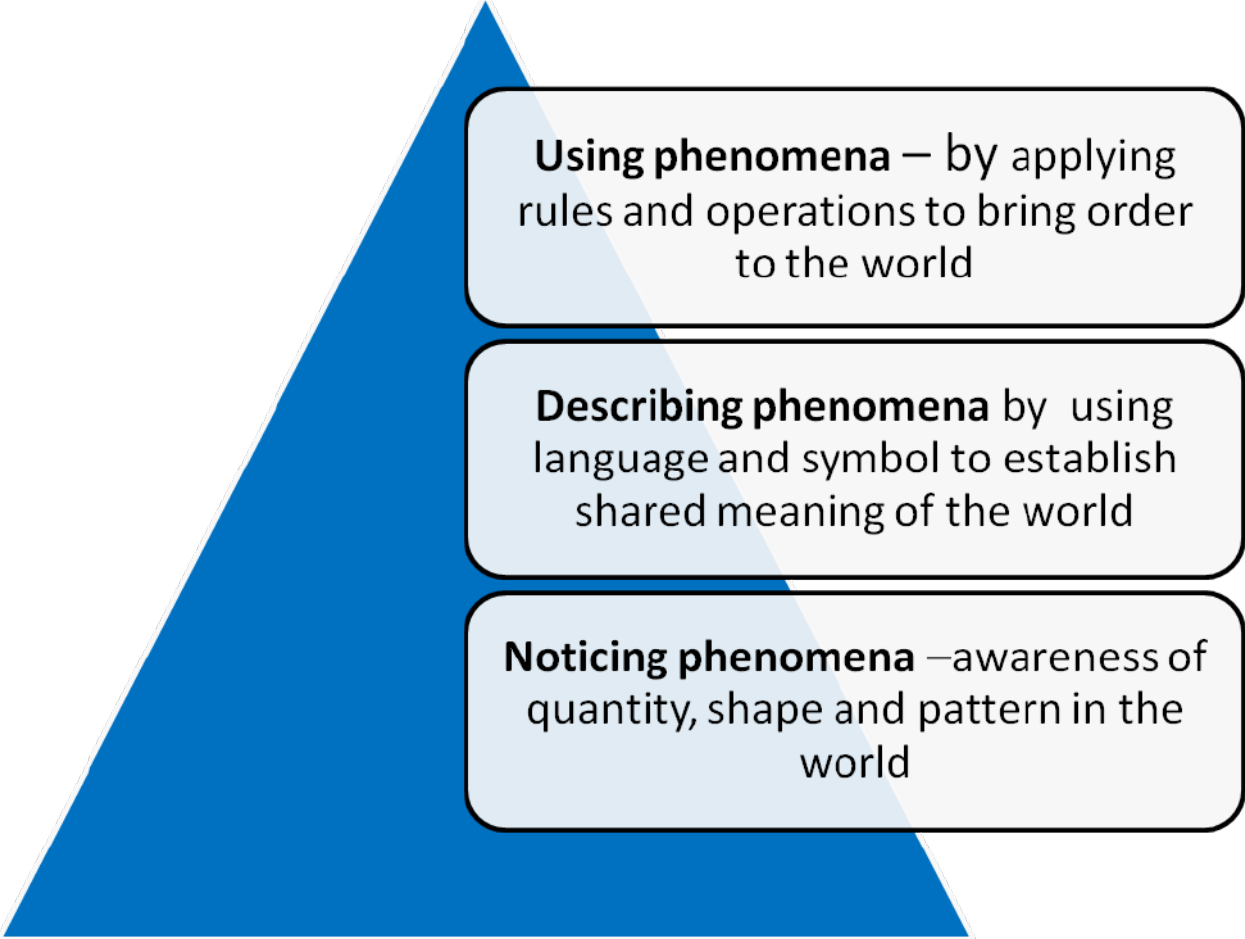
- Vygotsky (1929/1993) argued that identifying students' emerging skills and scaffolding learning appropriately will have the greatest impact on student learning
- A learning progression is a road or pathway that students travel as they progress towards mastery of the skills in the domain
- A progression designed for students with additional needs helps to see movement (forwards and backwards) and avoid unhelpful comparisons to 'bench marks' or 'norm-referenced' standards (Griffin, 2014)
- Learning progressions assist with coherence (Black, Wilson & Yao, 2012) and avoid 'haphazard' and disconnected planning and teaching (Heritage, 2008)

The design of an assessment for emergent numeracy

- This study replicates the methodology used to design assessments for a similar cohort in communication, literacy, interpersonal learning and intrapersonal development (Woods & Griffin, 2014)
- The design uses teacher observation of student behaviour in numeracy to measure increasing sophistication in a range of skills
- Comparing across many skills allows judgements to be made on the relative difficulty of steps (quality criteria) in questions (items) and a hypothesised framework be developed
- Data of actual performance on the items is compared to the hypothesised framework to see how reliable the items are at predicting student ability and detect whether the questions favour or disadvantage particular groups of students (i.e., students with ASD)

Defining the construct (what we are measuring)

Using symbolic representation of quantity, shape and pattern to bring order to the world.




Using phenomena – by applying rules and operations to bring order to the world

Describing phenomena by using language and symbol to establish shared meaning of the world

Noticing phenomena – awareness of quantity, shape and pattern in the world

An example item from the assessment

15. Comparing objects by size



15.3	Explains the difference between object sizes using comparative terms (e.g., bigger, smaller, longer, shorter, wider, broader, heavier, lighter)
15.2	Compares the size of two objects (e.g., by touching or looking at) and says, signs or indicates which is bigger or smaller
15.1	Explores different sized objects with guidance (e.g., touching, looking at)
15.0	Is moving towards, but has not yet achieved, these skills/behaviours



The assessment design process

- Literature on emergent numeracy and curriculum documents were reviewed to define the learning area and select the content
- Subject matter experts (both experienced special education teachers and numeracy academics) attended workshops to draft the construct and items
- Drafted questions (known as items) were panelled with experienced item writers and piloted in schools to check for clarity and understanding with teachers
- Schools were invited to participate in the trial via visits and phone calls
- Items were programmed onto the assessment platform and schools commenced assessing their students

Recruitment and participation in the trial

Recruitment

90 school principals invited from

a) Victorian special schools

b) Primary and secondary schools with a sizable cohort of students with a disability, who are past users of ABLES

Participation

2597 students from	Number of schools
Primary schools	9
Special schools	15
Specialist schools	13
Special developmental schools	19
Autism spectrum disorder schools	5
Physical disability schools and school for the deaf	5

Maths trial demographics

Mean score out of 65	33
Gender	72% males 28% females
Mean age	12 years
Std. deviation	3.6 years
School types	Special setting 94% Mainstream 6%

Disability category	Percentage of students
ASD	54%
Physical disability	19%
Vision impairment	8%
Severe behaviour disorder	7%
Hearing impairment	5%
Intellectual disability	72%
Severe language with critical educational needs	25%



THE UNIVERSITY OF
MELBOURNE

Variable Map

12		
11	X	
10	XX	
9	X	
	XX	
	XX	
8	XXX	
	XXXX	
7	XXXXX	
	XXXXX	
6	XXXXXXX	
	XXXXXXX	
5	XXXXXXXXXX	13.2
	XXXXXXXXXX	6.3 11.3
	XXXXXXXXXX	20.3
4	XXXXXXXXXXXXXXXXXXXX	7.3 14.3 18.3
	XXXXXXXXXXXXXXXXXXXX	10.3 21.3
3	XXXXXXXXXXXXXXXXXXXX	9.3 19.3 22.2 23.3
	XXXXXXXXXXXXXXXXXXXX	4.3 11.2 12.4 15.3 17.3
2	XXXXXXXXXXXXXXXXXXXX	2.2 16.2
	XXXXXXXXXXXXXXXXXXXX	14.2
1	XXXXXXXXXXXXXXXXXXXX	5.3 20.2
	XXXXXXXXXXXXXXXXXXXX	11.1 23.2
	XXXXXXXXXXXXXXXXXXXX	7.2 8.2 13.1 18.2 19.2 22.1
0	XXXXXXXXXXXXXXXXXXXX	3.2 4.2 6.2 10.2
	XXXXXXXXXXXXXXXXXXXX	1.4 9.2 17.2
-1	XXXXXXXXXXXXXXXXXXXX	5.2 12.3 15.2 21.2 23.1
	XXXXXXXXXXXXXXXXXXXX	1.3 2.1 4.1 14.1
-2	XXXXXXXXXXXXXXXXXXXX	19.1
	XXXXXXXXXXXXXXXXXXXX	1.2 12.2
-3	XXXXXXXXXXXXXXXXXXXX	5.1 9.1 10.1 16.1 20.1
	XXXXXXXXXXXXXXXXXXXX	6.1 7.1 8.1 18.1
	XXXXXXXXXXXXXXXXXXXX	3.1
-4	XXXXXXXXXXXXXXXXXXXX	21.1
	XXXXXXXXXXXXXXXXXXXX	12.1 15.1
-5	XXXXXXXXXXXX	17.1
	XXXXXXXXXX	1.1
-6	XXXXXXXXXX	
	XXXXXXXXXX	
-7	XX	
	XX	
	XX	
-8	X	
	X	
-9	X	
	X	
-10		
	X	
-11		

3.4% (74) of students scored 65

2597 students
assessed

Each 'X' represents
4 students

The numbers
represent the
items and their
steps

The higher the
item the fewer
students achieved
that item

2.3% (50) of students scored 0



Catering for all students

X	
XX	
X	
X	
XX	
XX	
XXX	
XXXX	
XXXXX	
XXXXX	
XXXXXX	
XXXXXX	
XXXXXXX	
XXXXXXX	
XXXXXXXX	
XXXXXXXX	
XXXXXXXX	13.2
XXXXXXXXXX	6.3 11.3
XXXXXXXXXX	20.3
XXXXXXXXXX	7.3 14.3 18.3
XXXXXXXXXX	10.3 21.3
XXXXXXXXXX	9.3 19.3 22.2 23.3
XXXXXXXXXX	4.3 11.2 12.4 15.3 17.3
XXXXXXXXXX	2.2 16.2
XXXXXXXXXX	14.2
XXXXXXXXXX	5.3 20.2
XXXXXXXXXX	11.1 23.2
XXXXXXXXXX	7.2 8.2 13.1 18.2 19.2 22.1
XXXXXXXXXX	3.2 4.2 6.2 10.2
XXXXXXXXXX	1.4 9.2 17.2
XXXXXXXXXX	5.2 12.3 15.2 21.2 23.1
XXXXXXXXXX	1.3 2.1 4.1 14.1
XXXXXXXXXX	19.1
XXXXXXXXXX	1.2 12.2
XXXXXXXXXX	5.1 9.1 10.1 16.1 20.1
XXXXXXXXXX	6.1 7.1 8.1 18.1
XXXXXXXXXX	3.1
XXXXXXXXXX	21.1
XXXXXXXXXX	12.1 15.1
XXXXXXXXXX	17.1
XXXXXXXXXX	1.1
XXXXXXXXXX	
XXXXXXXXXX	
XX	
XX	
XX	
X	
X	
X	
X	

The crosses in the red circles represent students who had more than 50% probability of being able to demonstrate all or none of the behaviours

A score of 0 or full marks gives the teacher no information to inform their teaching

IN RESPONSE...

Items have been written in an attempt to cater for these students

They are being trialled at present

Interpretation workshop

11	X	
	X	
10	X	
	XXX	
9	XX	
	XX	
8	XXX	
	XXXX	
7	XXX	
	XXXXXXXX	
	XXXXXXXX	
6	XXXXXXXX	
	XXXXXXXX	13.2
5	XXXXXXXXXXXX	6.3 11.3
	XXXXXXXXXXXX	20.3
4	XXXXXXXXXXXXXXXXXXXX	7.3 14.3 18.3
	XXXXXXXXXXXXXXXXXXXX	10.3 21.3
3	XXXXXXXXXXXXXXXXXXXX	9.3 19.3 23.3
	XXXXXXXXXXXXXXXXXXXX	4.3 12.4 15.3 17.3 22.2
2	XXXXXXXXXXXXXXXXXXXX	2.2 11.2 16.2
	XXXXXXXXXXXXXXXXXXXX	14.2
1	XXXXXXXXXXXXXXXXXXXX	5.3
	XXXXXXXXXXXXXXXXXXXX	11.1 20.2 23.2
	XXXXXXXXXXXXXXXXXXXX	7.2 8.2 13.1 18.2 19.2 22.1
0	XXXXXXXXXXXXXXXXXXXX	1.4 3.2 4.2 6.2 10.2
	XXXXXXXXXXXXXXXXXXXX	9.2
-1	XXXXXXXXXXXXXXXXXXXX	5.2 12.3 15.2 17.2 21.2 23.1
	XXXXXXXXXXXXXXXXXXXX	1.3 2.1 4.1 14.1
-2	XXXXXXXXXXXXXXXXXXXX	12.2 19.1
	XXXXXXXXXXXXXXXXXXXX	1.2
-3	XXXXXXXXXXXXXXXXXXXX	5.1 9.1 10.1 16.1 18.1 20.1
	XXXXXXXXXXXXXXXXXXXX	6.1 7.1 8.1
-4	XXXXXXXXXXXXXXXXXXXX	3.1
	XXXXXXXXXXXXXXXXXXXX	21.1
-5	XXXXXXXXXXXX	12.1 15.1
	XXXXXXXXXXXX	1.1 17.1
	XXXXXXXXXXXX	
-6	XXXXXX	
	XXXX	
-7	XXXX	
	XXX	
-8	XX	
	XXX	
-9	X	
-10	X	
-11	X	

- After initial data analysis a

workshop

was held with experienced
special education teachers

Teachers separated the
skills into conceptual levels (shown
in different shades of pink)

Teachers were asked to review
items with poor fit and make
improvements to their clarity

Teachers were asked to make
suggestions for easier and harder
questions

Mapping the progression to the Victorian Curriculum

Adds/subtracts numbers to solve number patterns and explains reasoning to reach the solution

Describes the different parts (e.g., half, quarter, third) after dividing an object

Explains the use of skip counting in everyday situations

Predicts the chance of an outcome in a familiar situation

Describes the sharing of a collection of objects (e.g., 'we have half each')

Measures two objects to the nearest cm using a ruler and explains which is longer

Creates and/or explains a pattern comprising different objects, sounds, or movements

Uses a strategy (other than recount) to find the new total when items are subtracted from a group

Interprets meaning from an unfamiliar representation containing multiple pieces of information

Uses a strategy (not recount) to find the new total when items have been added to the group

Explains a sequence of events using ordinal numbers

Orders Australian coins and notes by their relative value from highest to lowest

Describes the duration of events using the everyday language of time

Connects number words to numerals to at least 100

Identifies common 2D shapes and 3D objects within the environment

Skip counts objects in counting activities (e.g., counters in an array or pile)

Explains the difference between object sizes using comparative terms

Explains (e.g., by saying) placement of an object to another person using directional terms

Classifies a set of objects into different possible groups and explains decisions

Explains the total number of objects does not change when their position is rearranged

Compares the length of two objects using an informal measure (e.g., foot)

Sequences numerals forwards and backwards from 0 to 20 and above

Identifies Australian coins and notes using their value name

Produces number sequence in twos, fives or tens with support

Uses language of chance to comment on whether a familiar event might occur

Produces (e.g., says, signs, points to) ordinal numbers from first to third

Identifies the missing element in a number pattern (e.g., 1, 2, __, 4 or 8, 6, __, 2)

Comments on the relative duration of events (e.g., says one was shorter or longer)

Names change when an object has been added or removed from the group

Extends an alternating pattern (e.g., dash, dot, dash, dot or red, blue, red, blue)

Splits a collection of objects into subgroups following a demonstration

Identifies number word for numeral (including 0) up to 10

Indicates (e.g., say, signs) the total of a collection of objects 1-3 without counting

Splits an object into parts when asked or immediately following a demonstration

Uses concrete materials to recount to find the total when items have been removed

Counts to find the total when asked 'how many?' for a group of up to ten objects

Uses concrete materials to recount to find the total when items have been added

Follows directional terms (e.g., behind, in front, next to, beside) to locate an object

Names familiar 2D shapes (e.g., circle, square, triangle)

Orders numerals from 0 - 10

Sorts tokens, counters, coins, or notes into like groups

Compares the size of two objects and says which is smaller or bigger

Completes a familiar task following information presented in a sequence of steps

Sequences number words connected to three objects

Indicates the longer of two objects when asked

Checks quantity/total of objects after their position is rearranged

Matches numerals up to 5 to number words that are spoken or signed

Responds to the use of ordinal numbers by another

Sorts shapes/objects into like groups with support or prompting

Names some numbers (e.g., saying, signing)

Takes an item away from a group when asked

Sorts objects into 'like' groups based on a single attribute

Places numerals 1 - 5 in order with support

Adds an extra item to a small group when asked

Matches two objects that are the same from a collection of three objects

Shows surprise at an unexpected event

Attends to a collection being divided

Attends to an object being divided into parts

Responds when an object is added or removed from the group

Reacts to a representation of 1-3 objects

Attends to representations of an event

Responds to different shapes when presented by another person

Explores different sized objects with guidance (e.g., touching, looking at)

Attends to (e.g., looks or gestures towards) the movement of an object

Attends to another person's counting activity (e.g., looks, listens, turns towards)

3

2

1

F

D

C

B

A

These skills link to those found in Foundation-3 Levels of Victorian Curriculum

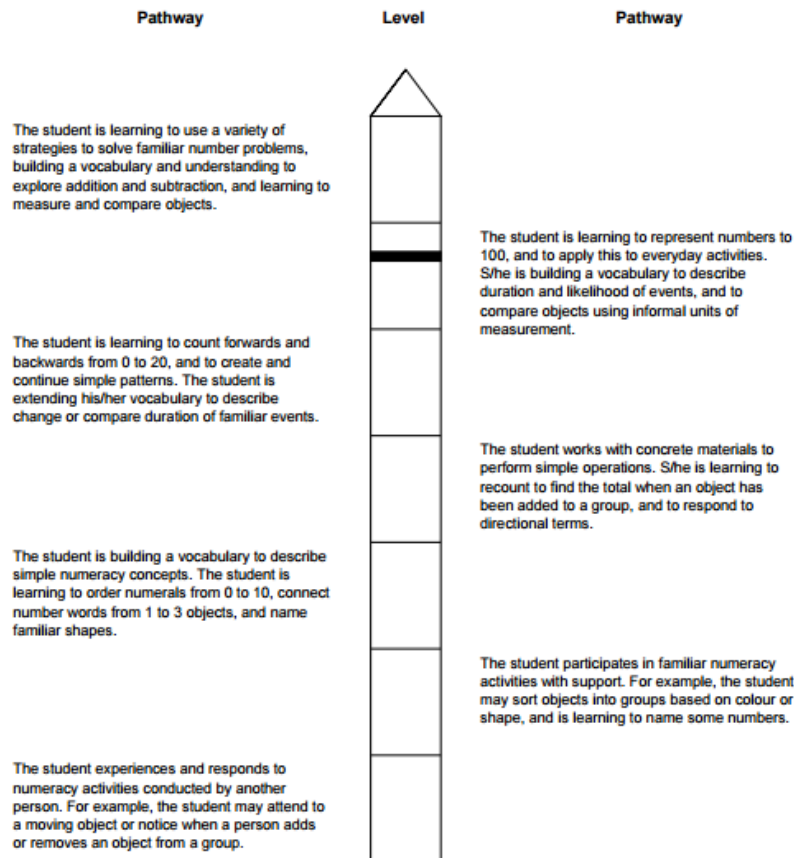
Skills that are not coloured are not matched to content in the Victorian Curriculum


These skills link to those found in the A-D Levels of the Victorian Curriculum

Information provided to the teachers

Learning Readiness Report

Student name:
Student code: **AAA0003**
Student class:
School code: **9999**
Assessment: **Mathematics**
Period: **Round 2 2015**
Date: **7 August, 2015**



 The student is estimated to be at this location

This report is generated to visualise and describe the conceptual level the student is at, and adjacent levels

In July, a large workshop with teachers will be held to connect teaching advice to each of these levels

A trial of revised items (including some that are harder and easier) is underway to cater for a broader cohort of students



Learner at the centre

This assessment ultimately places the learner at the centre, because it:

- Recognises skills not described by other assessments
- Gives teachers the resources to observe the skills of each student
- Places the student on an empirically derived numeracy progression
- Will eventually give teachers advice on how to plan lessons centred on the needs of each student

References

- Australian Curriculum, Assessment and Reporting Authority (2014). NAPLAN Achievement in Reading, Persuasive Writing, Language Conventions and Numeracy: National Report for 2014, ACARA, Sydney.
- Australian Government Attorney-General's Department. (2005). Disability Standards for Education 2005. Retrieved December 15, 2015, from <http://www.ag.gov.au/Humanrightsandantidiscrimination/Pages/Disabilitystandardsforeducation.aspx>
- Black, P., Wilson, M., & Yao, S. Y. (2011). Road maps for learning: A guide to the navigation of learning progressions. *Measurement: Interdisciplinary Research & Perspective*, 9(2-3), 71-123.
- Commonwealth of Australia. (2016). Access to real learning: the impact of policy, funding and culture on students with disability, being a report of the Senate Standing Committee on Education. Canberra: Australian Government Publishing Service. Retrieved 18 January 2016 from http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Education_and_Employment/students_with_disability/Report
- Geist, E. (2001). Children are Born Mathematicians: Producing the construction of Early Mathematical concepts in children under five. *Young children*, 56(4), pp12-19.

References

- Griffin, P. (2014). *Assessment for teaching*. Melbourne, Australia: Cambridge University Press.
- Heritage, M. (2008). *Learning progressions: Supporting instruction and formative assessment*. Washington, DC: Council of Chief State School Officers. Retrieved from www.ccsso.org/content/PDFs/FAST%20Learning%20Progressions.pdf
- *OECD (2012) Literacy, Numeracy, and Problem Solving in Technology-Rich Environments: Framework for the OECD Survey of Adult Skills, OECD Publishing.* http://www.oecd-ilibrary.org/education/literacy-numeracy-and-problem-solving-in-technology-rich-environments_9789264128859-en.
- *Victorian Curriculum and Assessment Authority (VCAA). (2015). Victorian Curriculum: Foundation–10.[Electronic version] Retrieved 30th July, 2015 from* <http://victoriancurriculum.vcaa.vic.edu.au/>
- *Victorian Equal Opportunity and Human Rights Commission. (2012). Held Back: The experiences of students with disabilities in Victorian school. Victorian Equal Opportunity and Human Rights Commission: Carlton, Melbourne.*
- *Vygotsky, L.S. (1929/1993). The collected works of L. S. Vygotsky, Volume 2: The fundamentals of defectology (abnormal psychology and learning disabilities)(R. W. Rieber & A. S. Carton, Trans.). New York: Plenum Press.*



MELBOURNE GRADUATE
SCHOOL OF EDUCATION



Department of
Education & Training

The SWANs study was funded by an Australian Research Council Linkage Grant, with support from the Victorian Department of Education and Training (DET) and the Centre for Advanced Assessment and Therapy Services.

The ABLES and Early ABLES research was funded by the Victorian DET's Student Wellbeing Division.

The SWANs General Capabilities Research is funded by an ARC Linkage Grant, again as a partnership between the University of Melbourne and DET.

