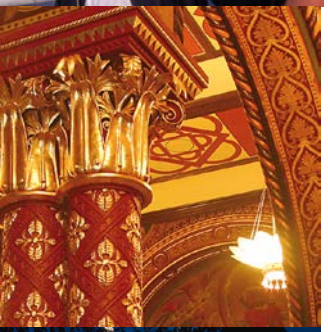

KING'S College LONDON

Frameworks for Mathematics: Some Key Principles

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1) Understanding/connections and processes/practices generally progress; facts and procedures come and go.

Low attaining Y3 children's recall of 4+5 or 5+3 after 5 days' teaching

	Ch	Je	Pe	Dn	Jy	Th	Ph
1 day				√			√
1 week							√
5 mths							
10mths							√
18mths			√		√	√	√

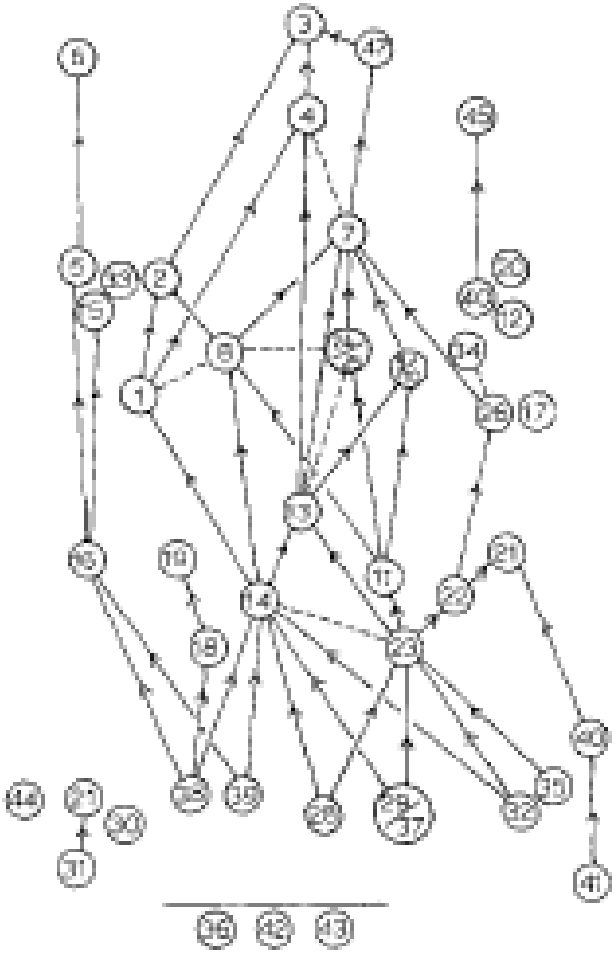
Denvir & Brown (1986b)

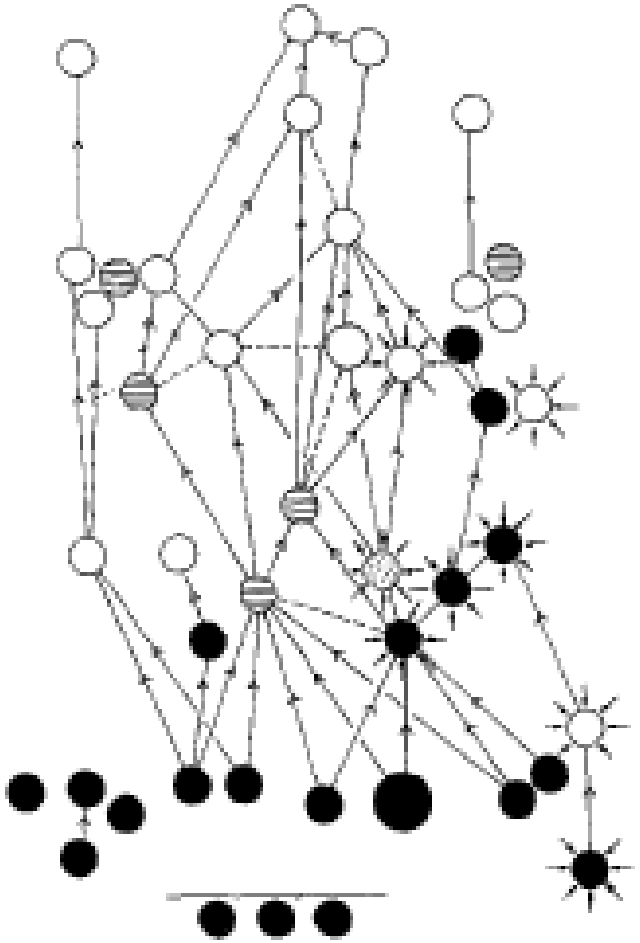
CSMS: Adding fractions (1977)

	Year 7	Year 8	Year 9	Year 10
$\frac{1}{3} + \frac{1}{4} =$	54%	38%	35%	45%
$32\frac{2}{3} + 5\frac{1}{4} =$	43%	25%	23%	24%
$\frac{5}{10} = \frac{?}{30}$	66%	68%	71%	75%
$\frac{2}{3} = \frac{?}{15}$	59%	58%	63%	64%

2) Long-term learning of facts & procedures is underpinned by understanding/ connections (and especially actions and images)

Numeracy Learning Hierarchy
(Denvir & Brown, 1986)



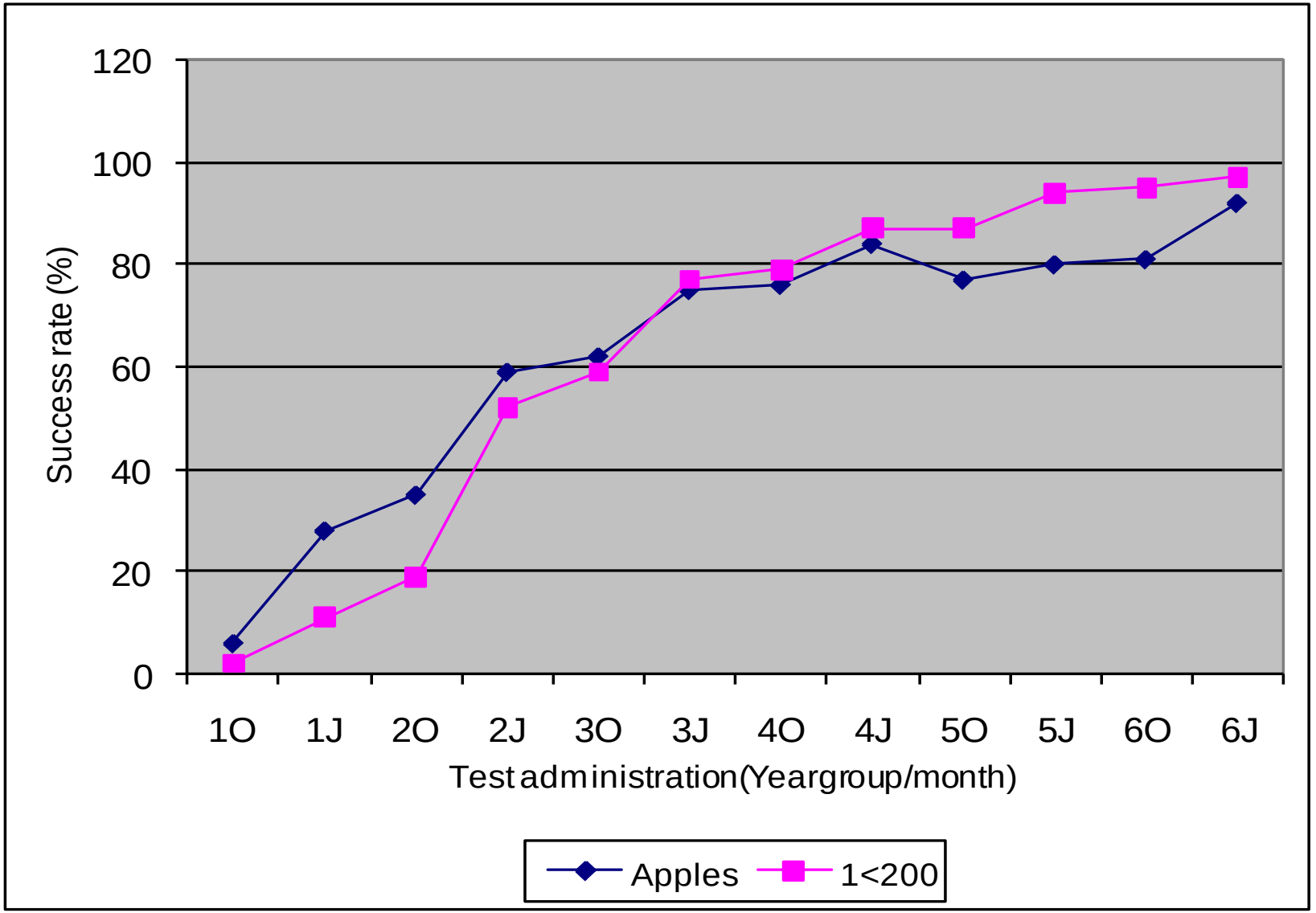


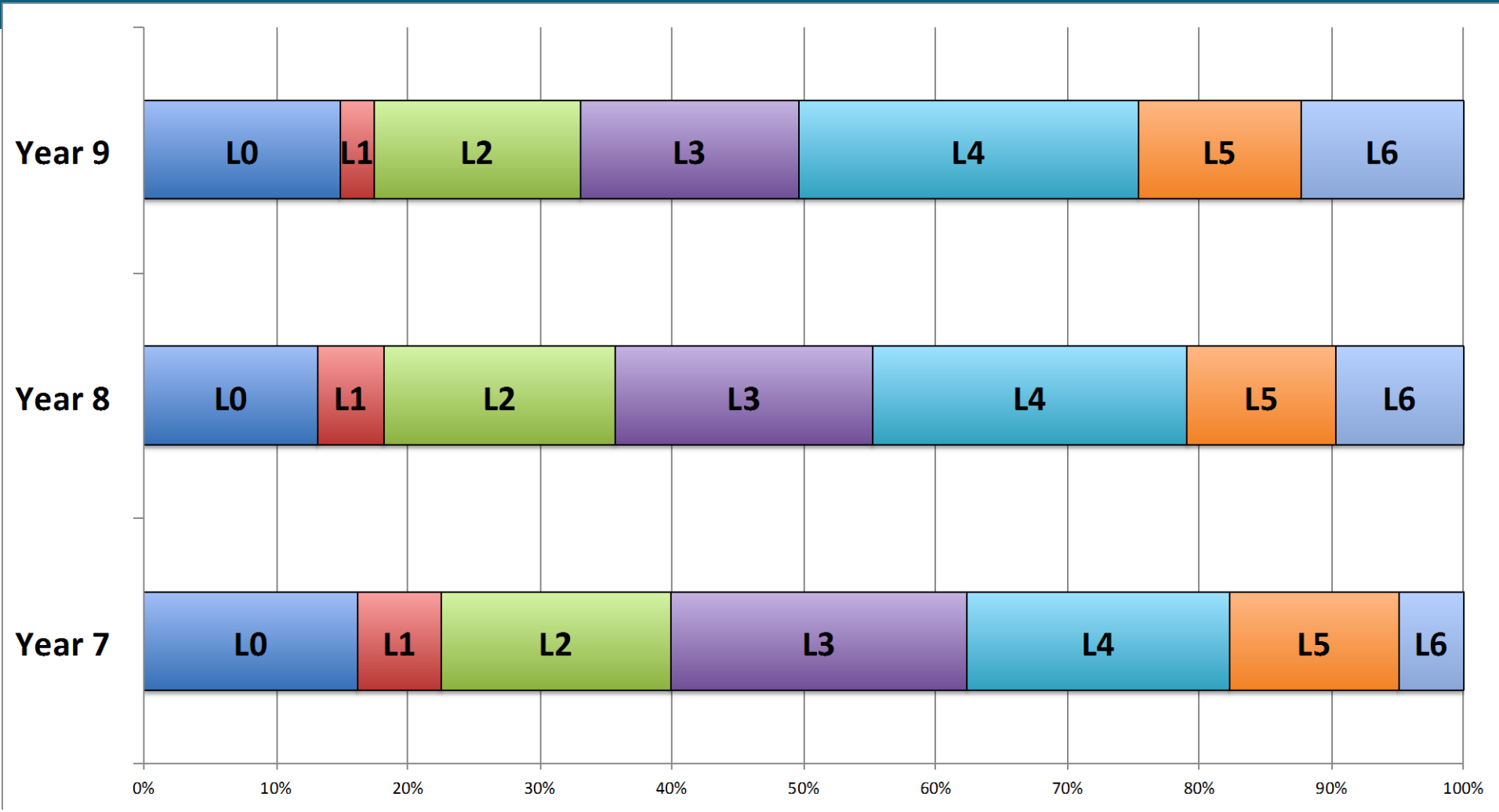
So…

- Should threshold assessment mainly assess understanding & application of key ideas or facts and procedures?
- Can we easily classify questions as testing either facts/procedures or understanding – doesn't the balance depend on the learner's knowledge?

3) Developing connections takes time, more for some than others.

Armchair curriculum designers depending on logic rather than empirical evidence can have a rose-tinted view (memory?) of what students might know and how fast can learn.


120
100
80
60
40
20
0
Success rate (%)
1O
1J
2O
2J
3O
3J
4O
4J
5O
5J
6O
6J
Test administration(Yeargroup/month)
Apples
1<200



	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Year 9	15%	3%	16%	17%	26%	12%	12%
Year 8	13%	5%	18%	20%	24%	11%	10%
Year 7	16%	6%	17%	22%	20%	13%	5%

Number (Place-value and decimals): 2008-9

Evidence from US Common Core (adapted from Hirsch)

In New York City/NY State, testing on new curriculum for grades 3-8 began in 2013 (most of rest of country follows in 2015)

30% /31% passed maths (down from 60%/65%)

In NYC, 15% African Americans & 19% Hispanics passed (9 schools with no passes)

So…

- Can we zoom in to describe empirically small progressive steps which lead to greater fluency and application (e.g. NNS framework) without leading to an over-detailed and fragmented curriculum?
- How loosely age-related should the framework be?

4) Processes/practices progress according to complexity of mathematical content and application (e.g. type and number of variables).

So…..

How can progression in problem-solving best be described?

A few minor quibbles…

- Isn’t measurement always about numbers, but only sometimes about spatial quantities?
- Isn’t logic a branch of mathematics, not just a mathematical practice?
- Should processes be identified with stages in modelling?

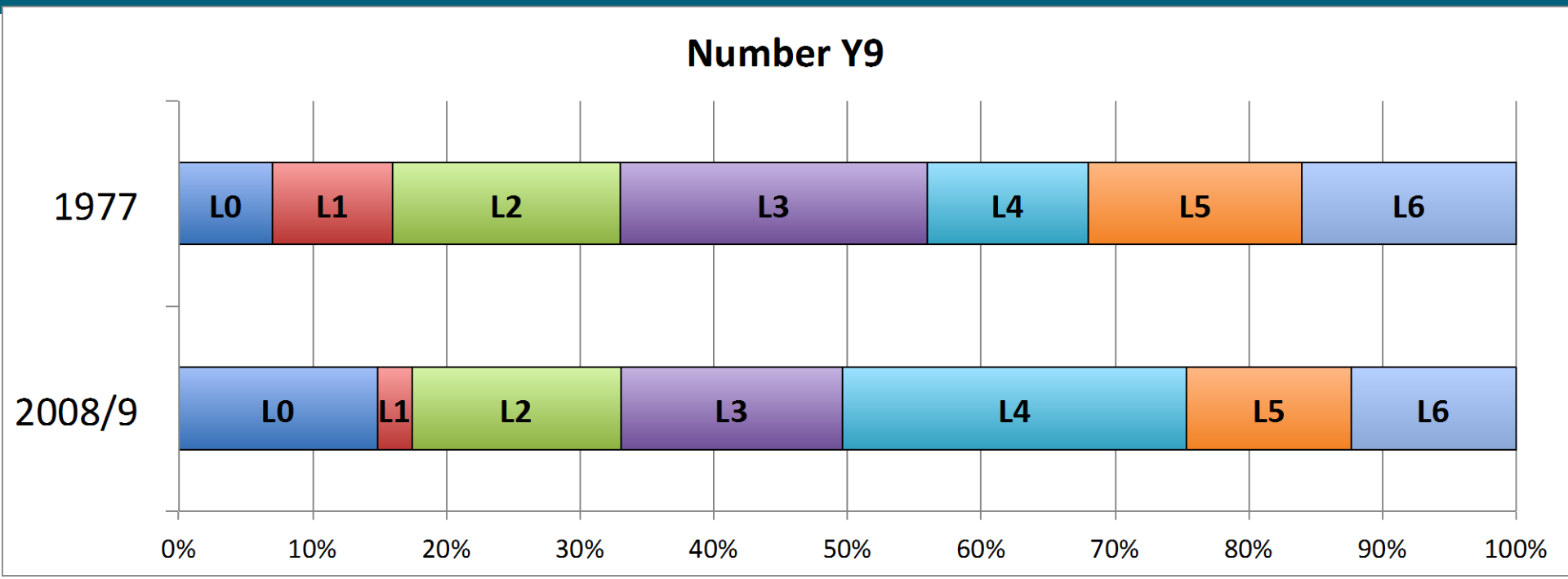
And finally…

Can we please have a curriculum which looks forward to the realities of the mid-21st century rather than backwards to the 19th (whatever they choose to do in Singapore and Shanghai)?

PIMS results on measurement (Brown et al, 1996)

	Gp 1 (14-20)	Gp 2 (23-32)	Gp 3 (32-40)	Gp 4 (40-47)	Gp 5 (49-56)	Gp 6 (56-66)	Gp 7 (76)
Year 8			2		4	4	1
Year 6			2	2	4	3	
Year 4		1	3	4	2		
Year 2	3	3	3		1	1	

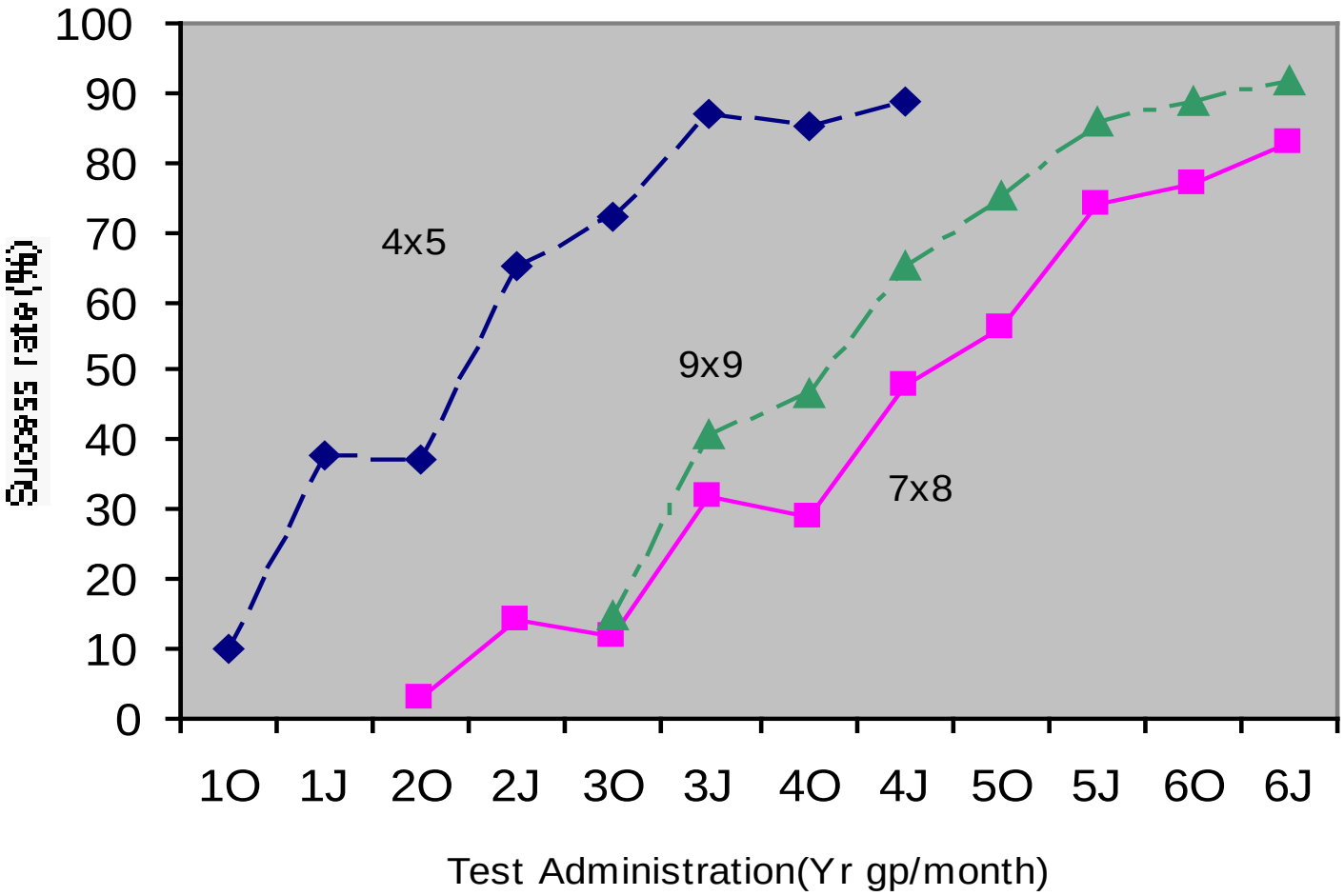
3 primary schools & 2 secondary schools, all middle-performing schools.
6 pupils representing a range from each year group.
Practical interview on measuring length and mass.
Performance groups based on types of response (scores out of 80)

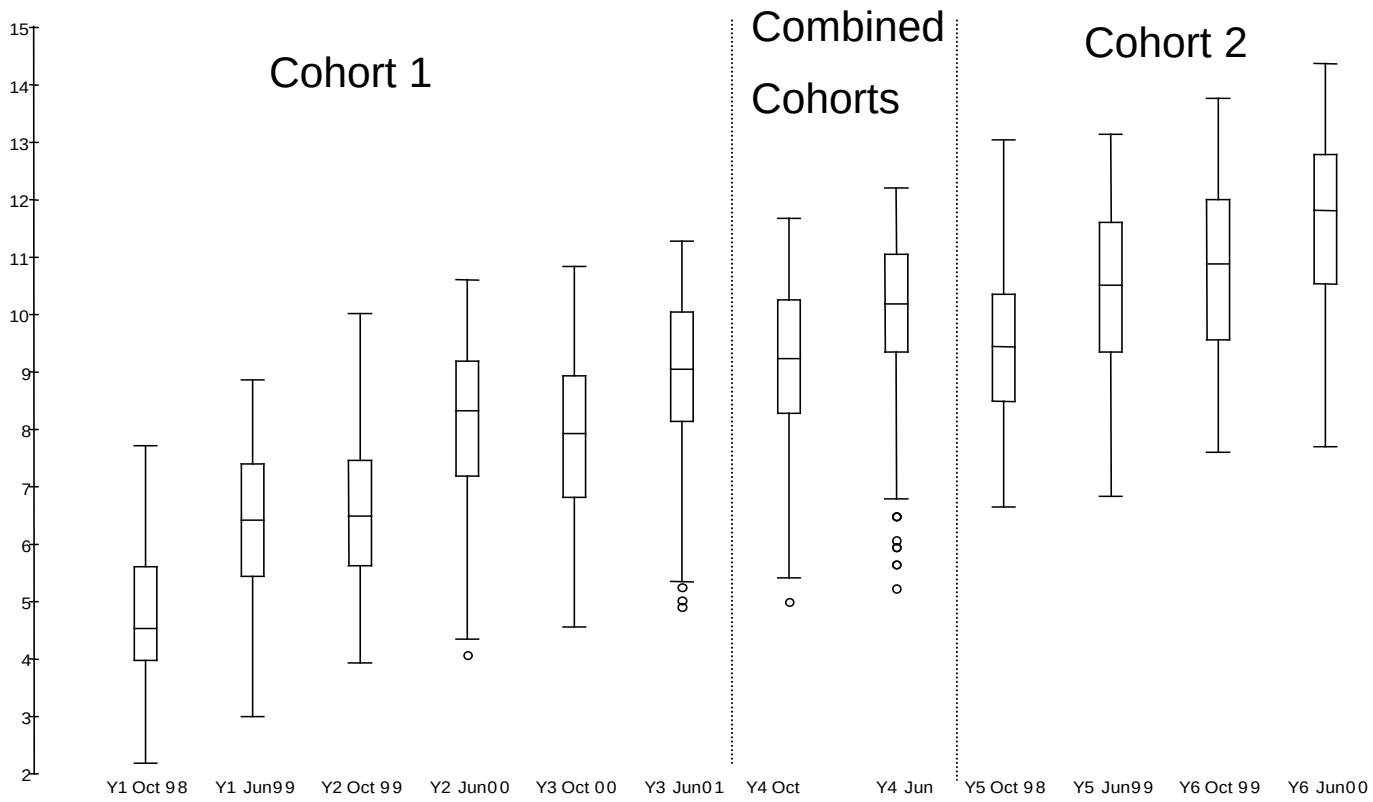


	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1977	7%	9%	17%	23%	12%	16%	16%
2008/9	15%	3%	16%	17%	26%	12%	12%

Mean increase in success rate on common items since the previous test

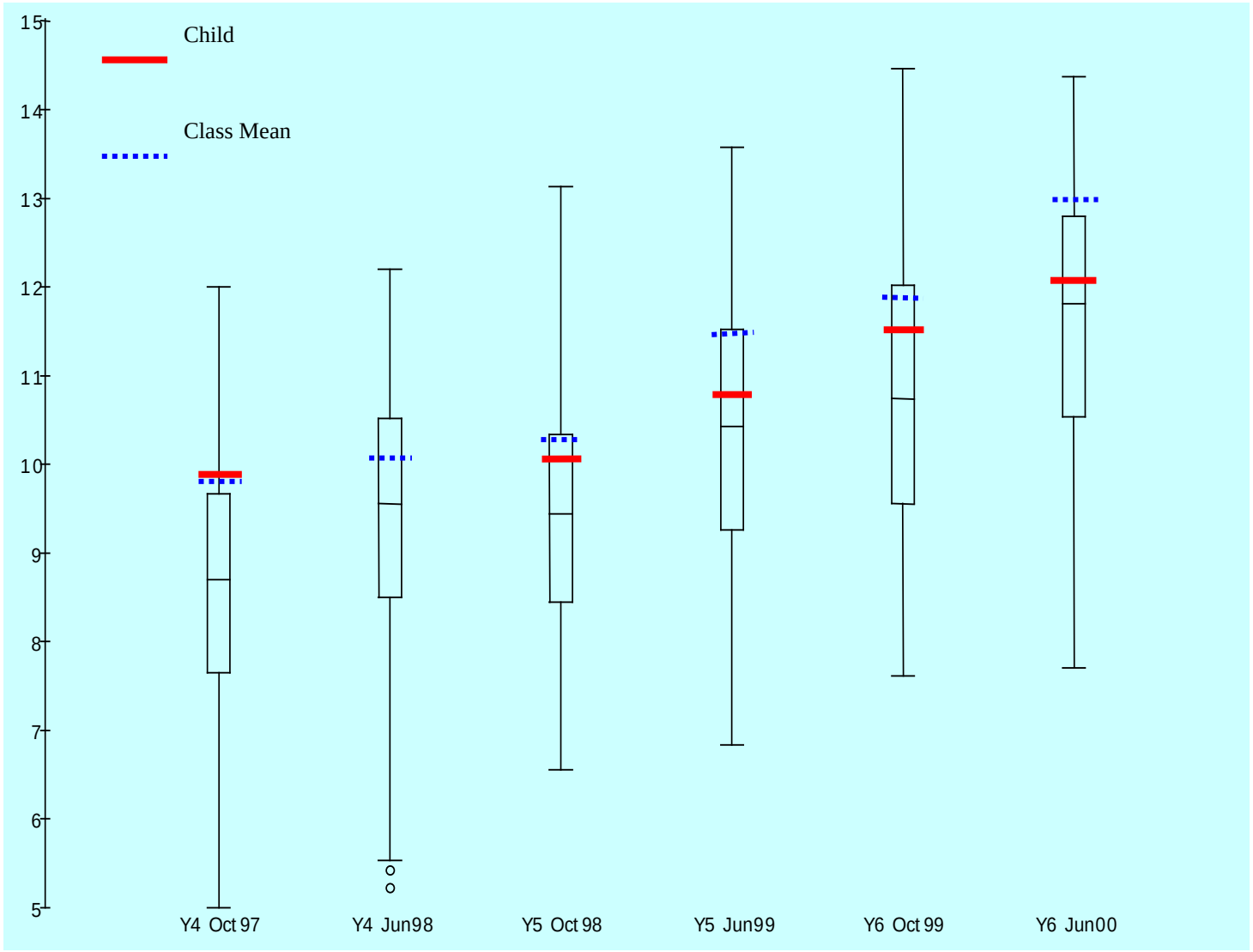
From	*To*	*Increase*
Year 1 Oct	Year 1 Jun	+20%
Year 1 Jun	Year 2 Oct	+ 5%
Year 2 Oct	Year 2 Jun	+20%
Year 2 Jun	Year 3 Oct	+ 2%
Year 3 Oct	Year 3 Jun	+13%
Year 3 Jun	Year 4 Oct	+ 2%
Year 4 Oct	Year 4 Jun	+10%
Year 4 Oct	*Year 4 Jun*	*+ 10%*
Year 4 Jun	*Year 5 Oct*	*+ 5%*
Year 5 Oct	*Year 5 Jun*	*+11%*
Year 5 Jun	*Year 6 Oct*	*+ 4%*
Year 6 Oct	*Year 6 Jun*	*+11%*
Year 6 Jun	*Year 7 Jun*	*- 2%**

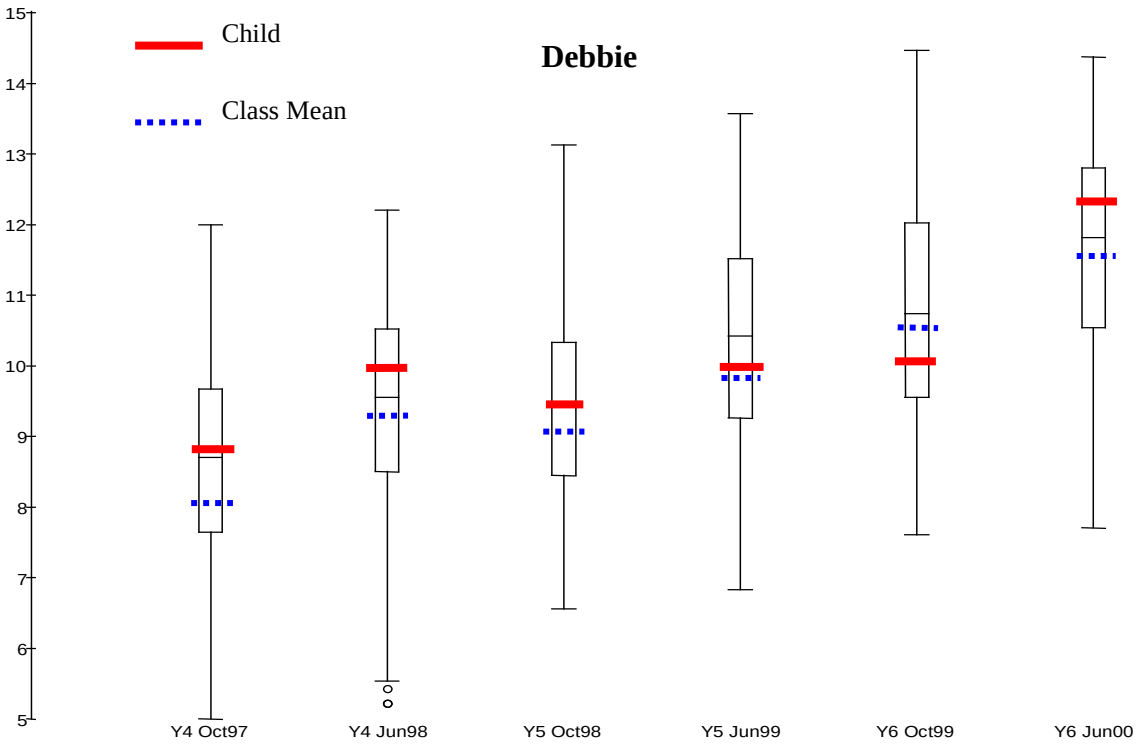

100
90
80
70
60
50
40
30
20
10
0
4x5
9x9
7x8
1O
1J
2O
2J
3O
3J
4O
4J
5O
5J
6O
6J
Test Administration(Yr gp/month)



Y1 to Y6 Progression (Y4 Cohort combined)

Joseph's progression in terms of numeracy age, in relation to his class and the sample (Cohort2)





Debbie (Cohort 2)