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Growth curve models in educational effectiveness research

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Why looking at growth ?

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Learning is changing !

Learning gains / Learning rates

Student growth / progress

Student outcomes over time

=> the essential criterion
in educational effectiveness studies ?

► Repeated measurements / longitudinal research

Measuring learning gains?

=> Learning gains of a student /of a school / of a country

Learning gains

- 2 or more measurement occasions

Corrected learning gain

- taking into account student background
- taking into account school context ?

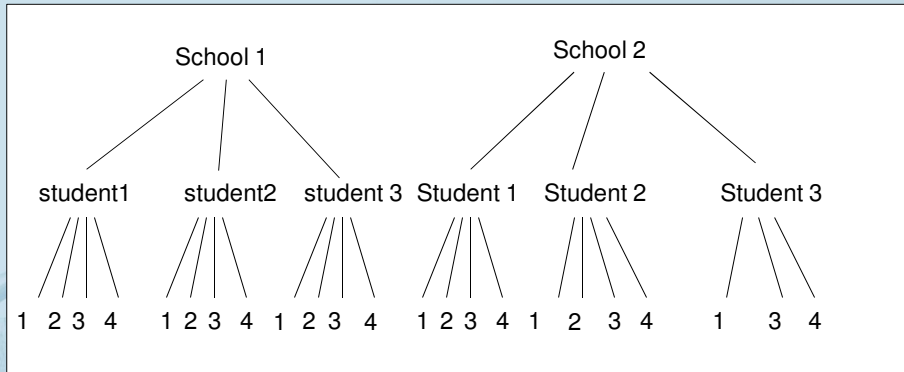
Growth curve model

≥ 2 measurement occasions at same scale

- Estimation of individual growth trajectories
- Student outcomes are modeled as a function of time
- 2 viewpoints
 - Multilevel modelling
 - Structural equation modelling

Growth curve model: 2 viewpoints

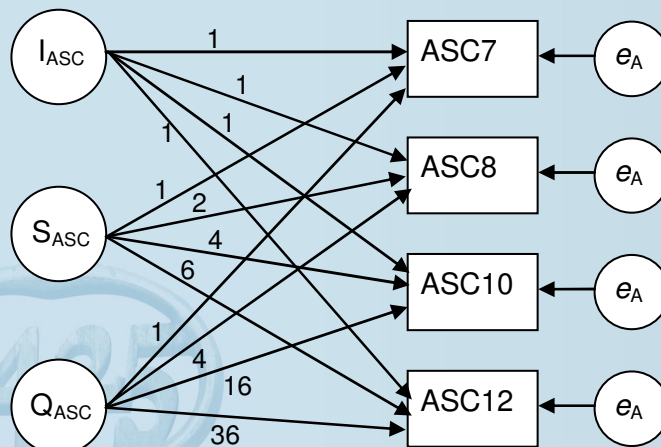
Multilevel Modelling



MLwiN

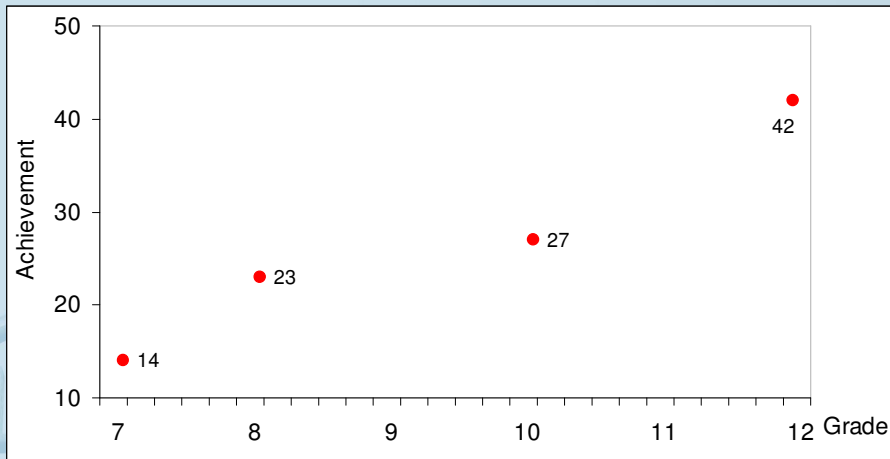
Growth curve model: 2 viewpoints

Structural Equation Modelling (SEM)

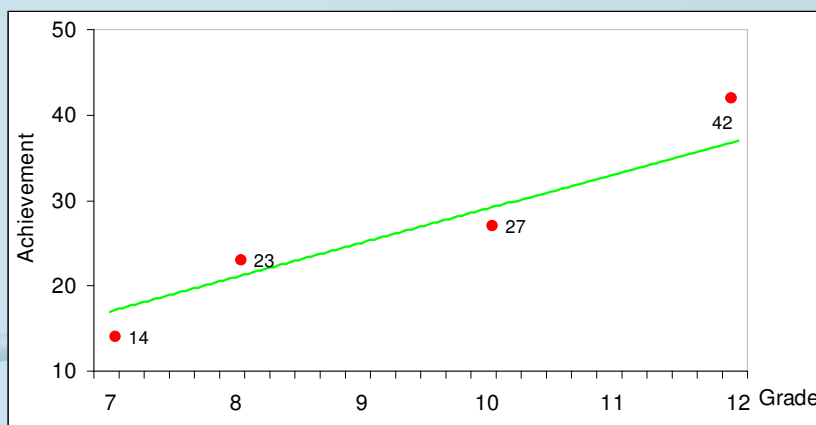


Mplus

Repeated measurements



Linear growth curve



Intercept = status = 17

$$\text{Achievement} = 17 + 4 \cdot (\text{Grade} - 7)$$

Slope = growth = 4

Example (1) : well-being in secondary school

Research question

How is student well-being changing in secondary education?

Method

Growth curve model

Data

LOSO

Well-being measured in

Grade 7

Grade 8

Grade 10

Grade 12

Time coding

Grade 7 = 0

Grade 8 = 1

Grade 10 = 3

Grade 12 = 5

Time coding

Grade 7 = -3

Grade 8 = -2

Grade 10 = 0

Grade 12 = 2

quadratic growth curve for well-being

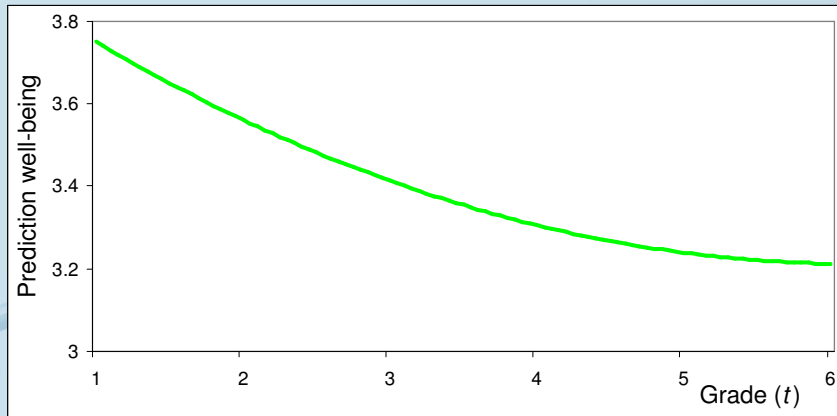
Well-being

Variable	Fixed effect	Level 1 variance	Student variance	School variance	N schools	
Int _(Grade 10)	3.303(0.020)	0.090(0.002)	0.186(0.007)	0.014(0.004)	N students	53
Linear	-0.085(0.005)		0.004(0.000)	0.001(0.000)	N measurements	3788
Quadr	0.020(0.002)		0.000(0.000)	0.000(0.000)	Deviance	12297
						14177.7

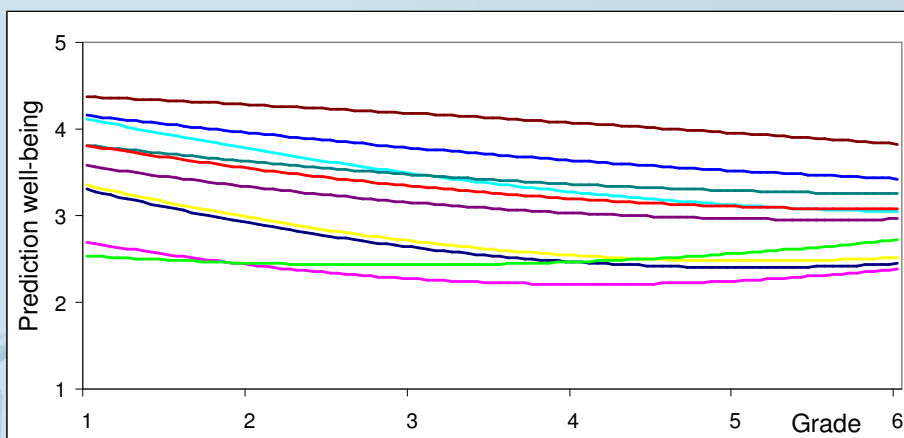
Variable	Correlations at Student level			Correlations at School level		
	1	(Grade-4)	(Grade-4) ²	1	(Grade-4)	(Grade-4) ²
1	1.000			1.000		
(Grade-4)	-0.136	1.000		0.279	1.000	
(Grade-4) ²	-0.908	-0.452	1.000	-0.478	0.211	1.000

Standard errors are in parentheses

Average quadratic growth curve



Quadratic growth curves for 10 students



Example (2) : traditional / alternative schools

Research question

- Effects of three types of schools on
- enjoyment of school
 - independent functioning

Method

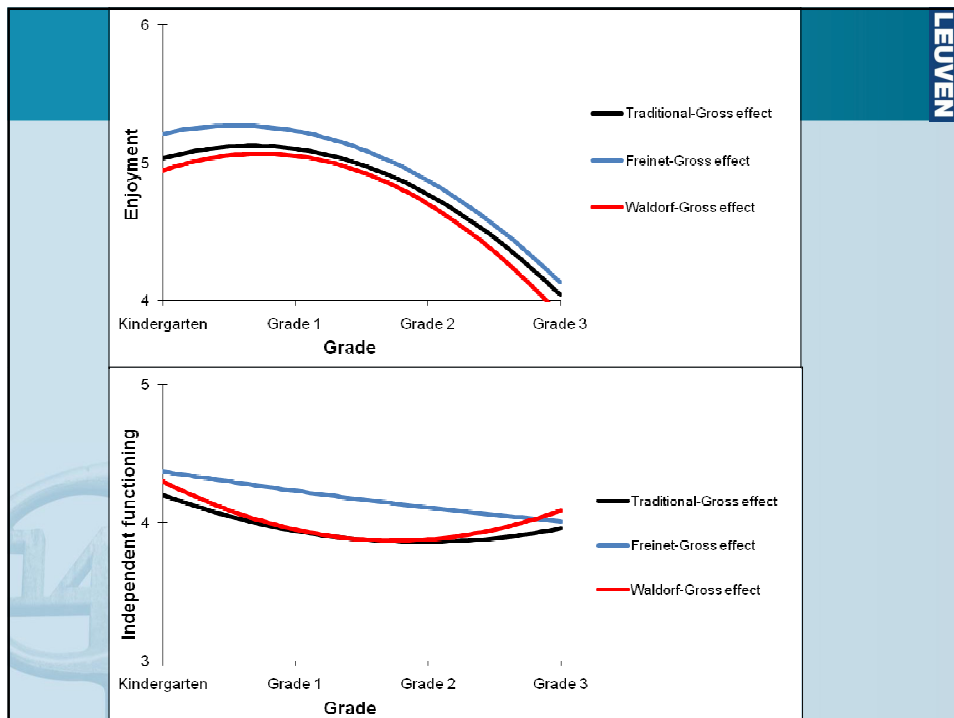
Growth curve models

Data

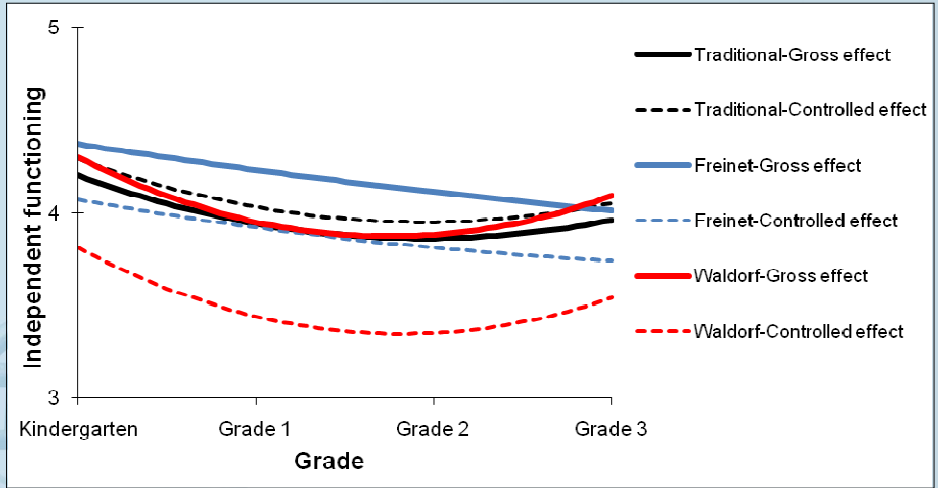
SiBO

1. Traditional schools
2. Freinet schools
3. Waldorf schools

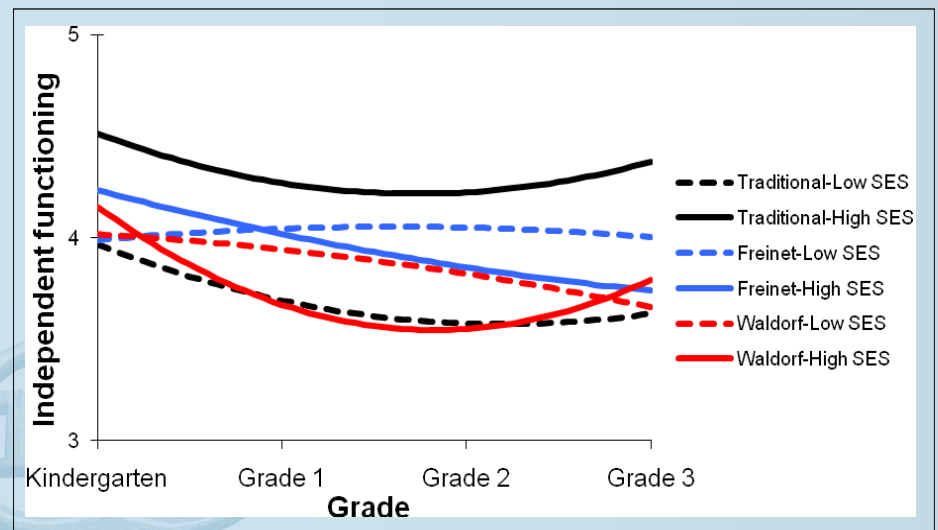
PhDstudent: Jerissa De Bilde



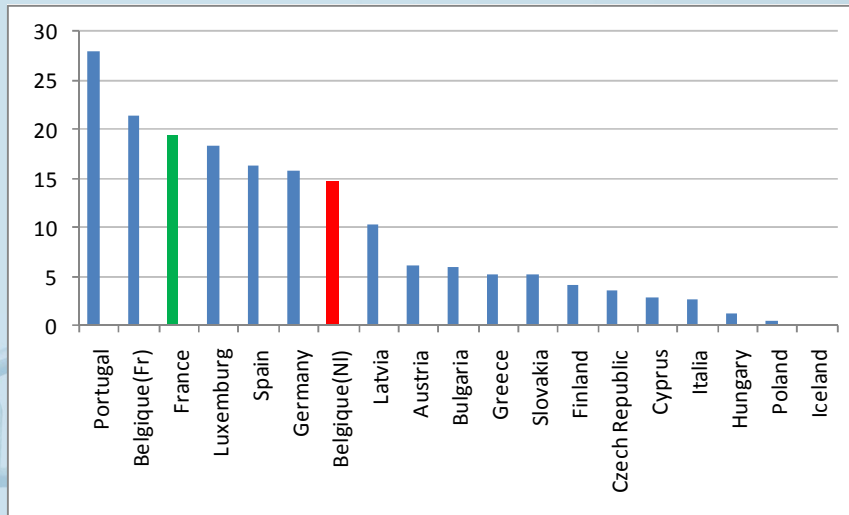
Value-added



Differential effects



Example (3) : grade retention



Grade retention in primary education (source: Eurostat, 2008)

Grade retention

Research question

Effects of repeating Grade 1 on children's further psychosocial growth in primary school

Method

Propensity score matching to correct for differences between promoted and retained students

- 68 prior student characteristics
- 59 prior class characteristics
- 42 prior school characteristics

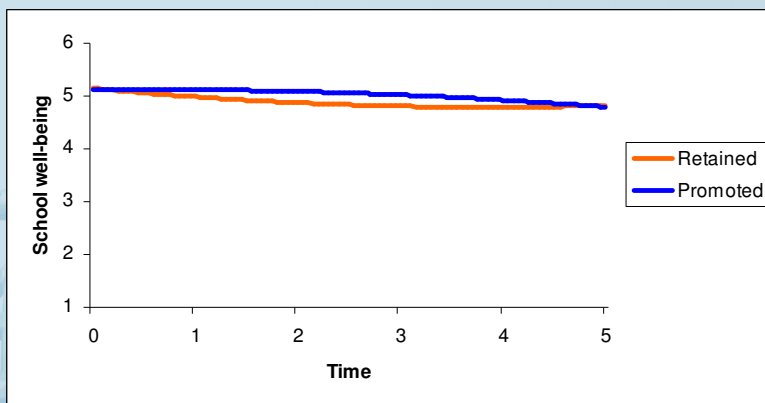
Data

SiBO

PhDstudent: Mieke Goos

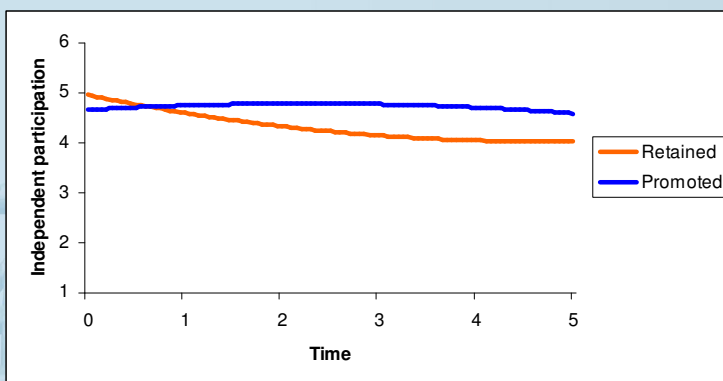
Grade retention

School well-being
SAME-AGE comparisons



Grade retention

Independency in the class
SAME-AGE comparisons



Example (4) : discontinuous growth

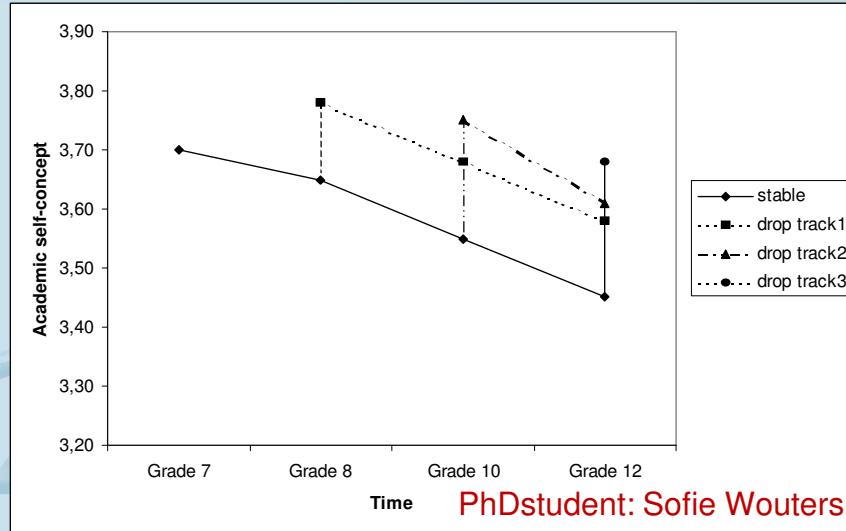
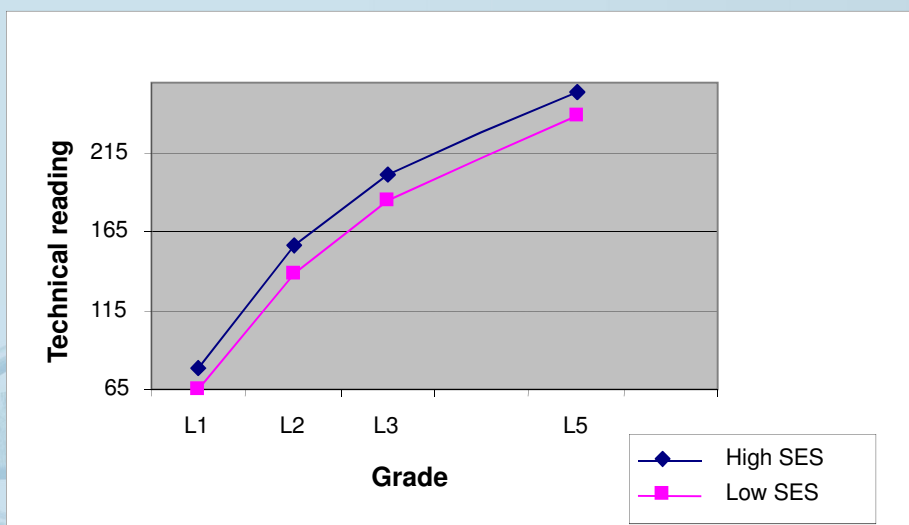
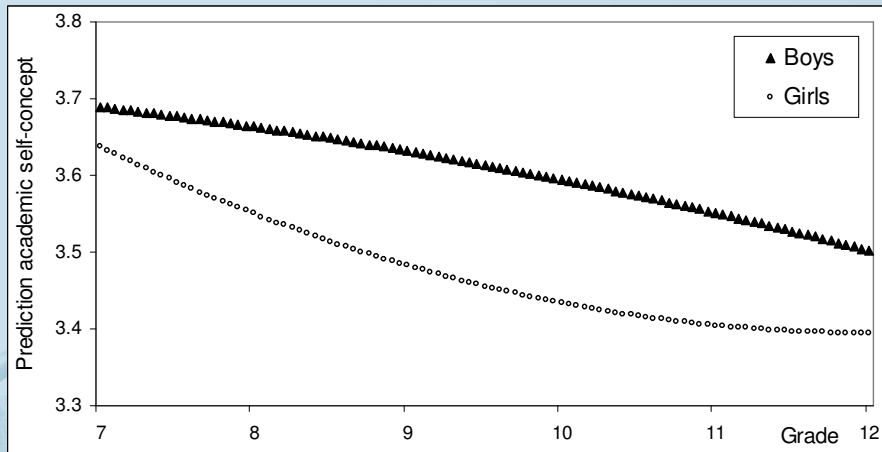


Illustration of the big-fish-little-pond effect in the cascade system

Example (5) : piece-wise growth



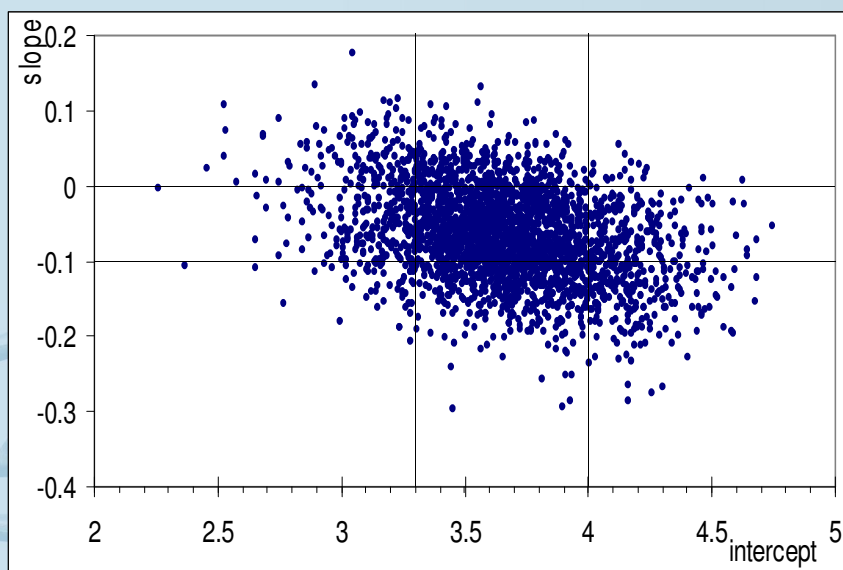
Example (6) : classification of growth curves



boys: $3.689 - 0.023 (\text{Grade}) - 0.003 (\text{Grade})^2$

girls: $3.637 - 0.097 (\text{Grade}) - 0.010 (\text{Grade})^2$

Intercepts & slopes



N students per growth curve-type

Slope	Intercept							
	Low		Average		High		Total	
Increasing	132	4 %	252	9 %	19	1 %	403	14 %
Slightly Declining	187	7 %	1 252	44 %	191	7 %	1 630	58 %
Strongly Declining	56	2 %	521	18 %	215	8 %	792	28 %
Total	375	13 %	2 025	72 %	425	15 %	2 825	100 %

Example (7) : school effects in growth curve models

Research Question

Do schools have a larger effect on student growth than on student status?

Few studies employ growth curve model WITH school level

Best known is the study of Raudenbush (1989, 1995)

=> spectacular results

Raudenbush (1989, 1995)

School effect on student status

Reading	Mathematics
14 %	14 %

School effect on student growth

Reading	Mathematics
44 %	> 80 %

=> a widely held belief that schools have a larger effect on student growth than on student status

Literature review

	<i>May et al. (2004)</i>			
	Reading	Reading	Math	Math
School effect on	Grade 1 - Grade 3	Grade 4 - Grade 8	Grade 1 - Grade 3	Grade 4 - Grade 8
status	7.8 %	2.8 %	9.0 %	6.0 %
growth	10.6 %	17.2 %	43.3 %	45.8 %

	<i>Raudenbush & Bryk (2002)</i>	<i>Zvoch & Stevens (2003)</i>	<i>Rhodes et al. (2004)</i>	
	Math	Language	Math	Self-esteem
School effect on	Grade 1 - Grade 3	Grade 6 - Grade 8	Grade 6 - Grade 8	Grade 6 - Grade 8
status	8.0 %	18 %	21 %	6 %
growth	58.3 %	84 %	42 %	9 %

Literature review

<i>Wilkins & Ma (2002, 2003)</i>						
School effect on	Stat istics	Alge bra	Geo metry	Attitude toward math	Social impact of math	Nature of math
status	15.2 %	13.0 %	14.1%	7.4 %	6.1 %	1.1 %
middle school growth	9.4 %	12.1 %	13.6%	7.4 %	5.3 %	1.7 %
high school growth	7.9 %	11.3 %	11.5%	4.3 %	3.8 %	2.7 %

<i>Reardon (2003)</i>		
School effect on	Reading	Math
status	20.1 %	25.0 %
kindergarten growth	19.7 %	15.5 %
summer growth	11.8 %	12.6 %
first grade growth	16.9 %	14.9 %

Literature review

School effect on	<i>Van Damme & De Fraine, 2005</i>		<i>Van de gaer et al., 2009</i>	
	Academic self- concept	Well- being	Academic self- concept	Motivation toward learning tasks
status	5.9 %	6.9 %	8.0 %	9.2 %
growth	7.8 %	14.0%	50.0 %	17.2 %
quadratic term	/	41.9 %		

<i>De Fraine, Van Damme, & Onghena, 2007</i>				
School effect on	Academic self-concept boys	Academic self-concept girls	Dutch boys	Dutch girls
status	7.82 %	9.38 %	55.86 %	53.80 %
growth	5.15 %	15.11 %	54.62 %	31.28 %

Growth curve models: conclusions

Advantages

Flexible, interesting, ...

Disadvantages

- Students changing school ?
- Students repeating a grade ?
- Class level / teacher level ?

Questions?

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