How Academic Achievement and Socioemotional Learning Are Structurally Linked

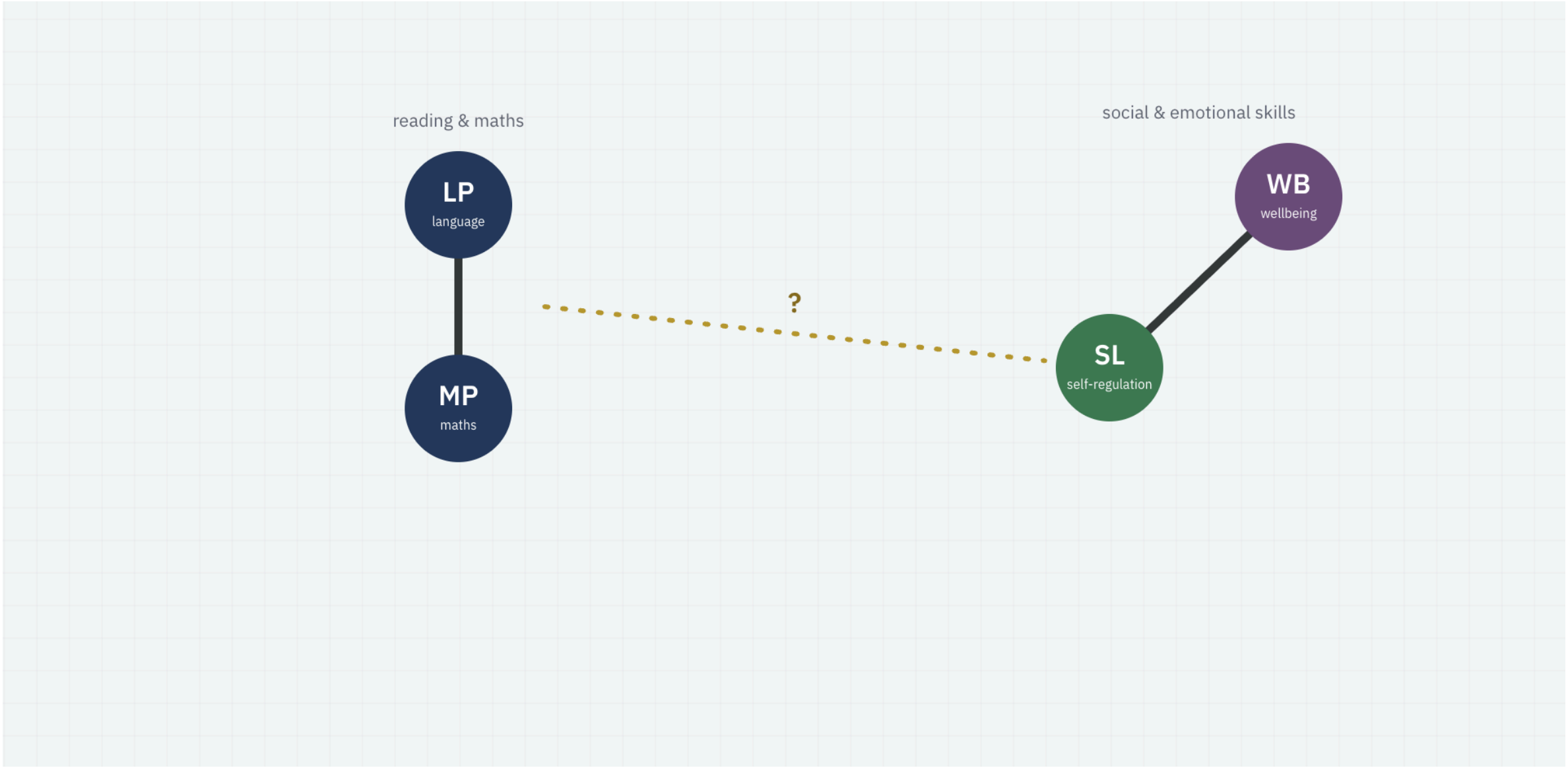
Causal Discovery Evidence From Peru's National Assessment

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01 Is there a direct edge?



02 Why ask

WHAT IS KNOWN

School programmes that teach social and emotional skills raise academic outcomes, and the gains can persist

meta-analyses: Durlak et al. 2011 · Taylor et al. 2017 · Corcoran et al. 2018 · Mahoney et al. 2018

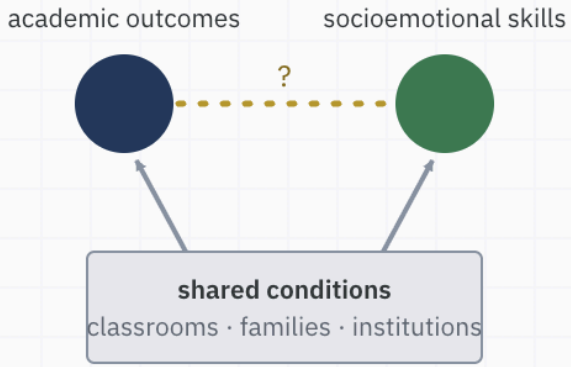
ALSO KNOWN

Population-scale assessments find weak direct associations between measured socioemotional skills and achievement

OECD 2024, Survey on Social and Emotional Skills

A READING THAT FITS BOTH

What links the two domains may not be a direct channel but shared conditions: classrooms, families, institutions



QUESTIONS

1. Which dependency structure among language, maths and self-regulation do the data support, once unmeasured common causes are allowed?
2. How much of that structure depends on the survey design, its weights and school clusters, rather than on the children?
3. Does the structure travel: across years, across grades, across countries?

03

Three sources, one method

2019

ERCE 2019

16 Latin American countries · 6th grade · one instrument · 80,827 pupils in the socioemotional module

UNESCO-LLECE

2022

Peru 2022

6th primary: 8,835 students · 2nd secondary: 104,099 · 14 socioemotional constructs

UMC, Ministry of Education

2024

ENLA 2024

64,420 students · 4,316 schools · 41 variables · the richest questionnaire

UMC, Ministry of Education



■ the 16 ERCE countries

ENLA 2024



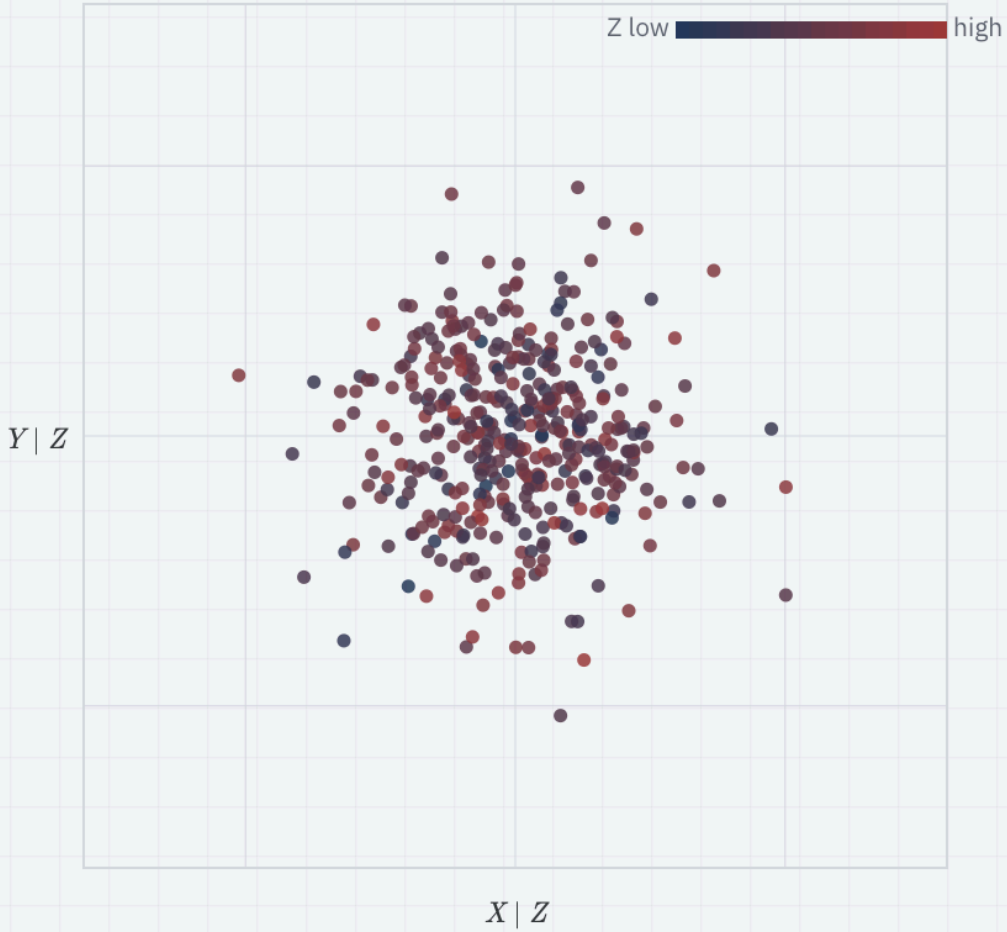
64,420
students with tests and questionnaires

4,316
schools

41
variables

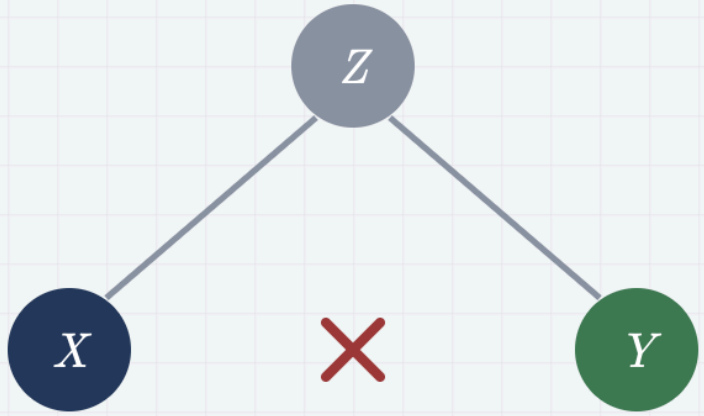
- language & maths scores (LP, MP)
- socioemotional learning (SL), 5 plausible values
- subjective wellbeing
- 37 more questionnaire constructs

One idea: conditional independence



correlation of X and Y

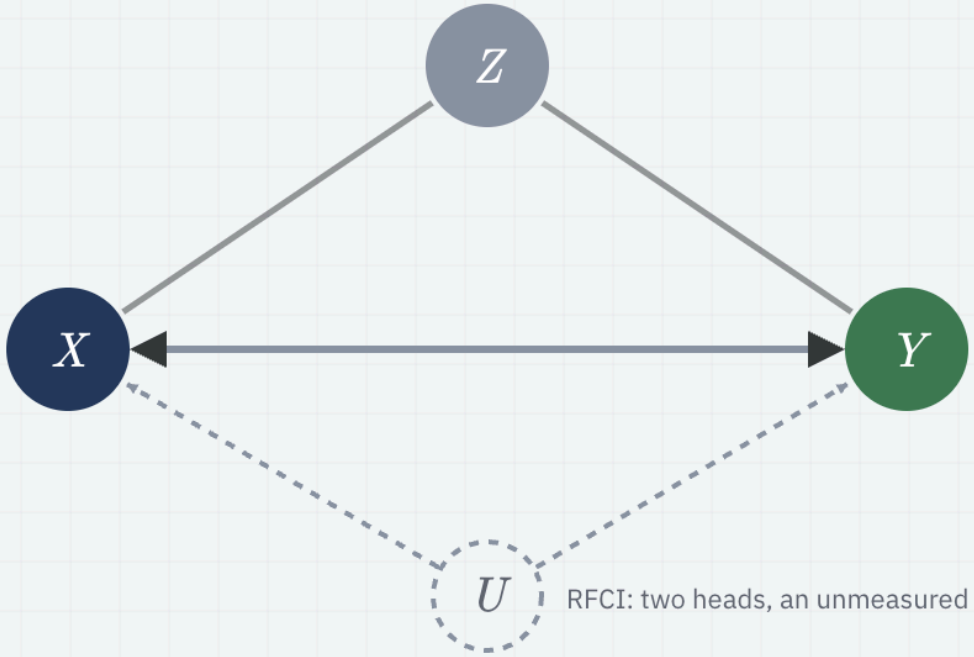
r = -0.01



$$X \perp Y \mid Z$$

simulated data, 400 points: Z drives both X and Y; the X–Y association is entirely through Z

Two algorithms, one test



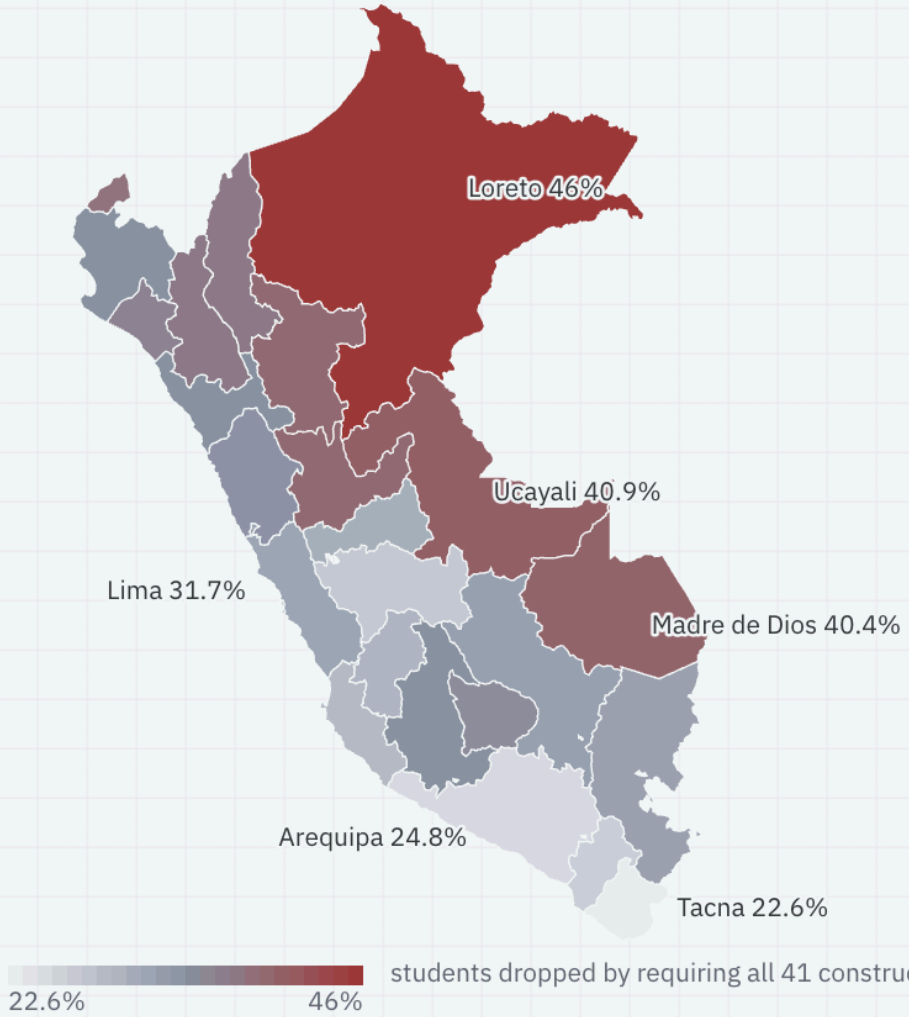
RFCI: two heads, an unmeasured cause U fits

$$z = \tfrac{1}{2} \ln \frac{1 + \hat{\rho}_{xy \cdot S}}{1 - \hat{\rho}_{xy \cdot S}}$$

edge if $\sqrt{n - |S| - 3}\,|z| > 1.96$

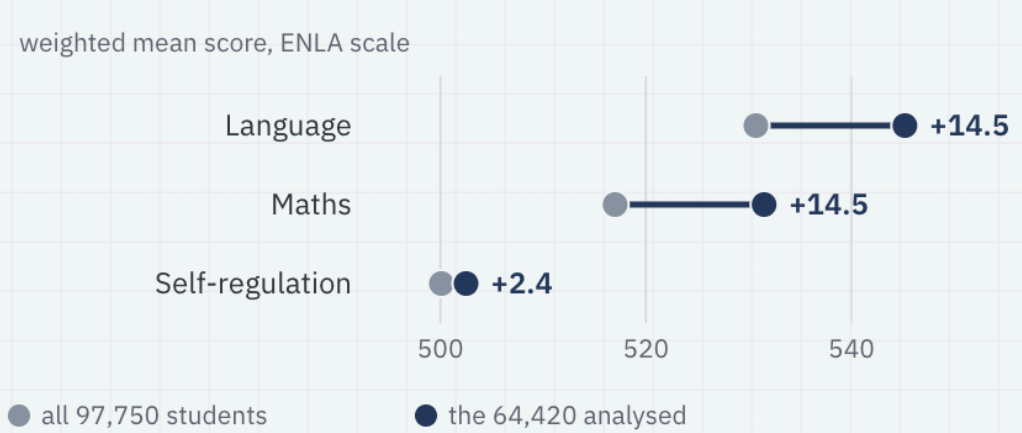
one test per pair *x*, *y* and conditioning set *S*

Who is in the data



66%

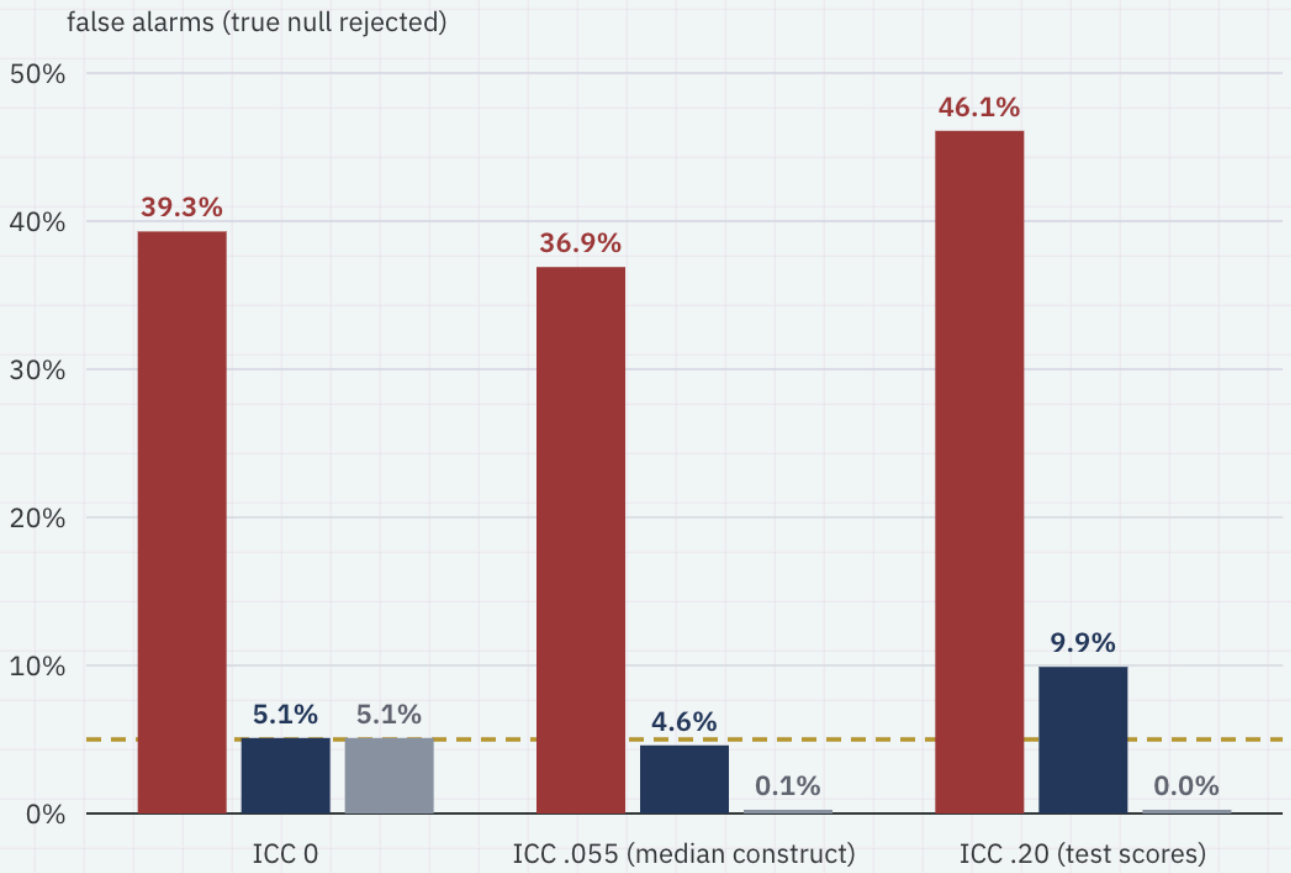
of the 97,750 merged students have all 41 constructs · 34.1% dropped, unevenly across the country



the analysed students score 14.5 points higher in language and in maths than all students, even weighted · the dropped third scores 28 points lower · poorest, rural and state-school students under-represented by 2–3 points

every result below is checked against this selection: resampling, reweighting, imputation, subgroups

Calibrating the test to the survey design



39%

raw n = 64,420: false alarms at a nominal 5%, from unequal weights alone

≈ 5%

Kish n_{eff} = 13,060 (≈ 10% for test scores)

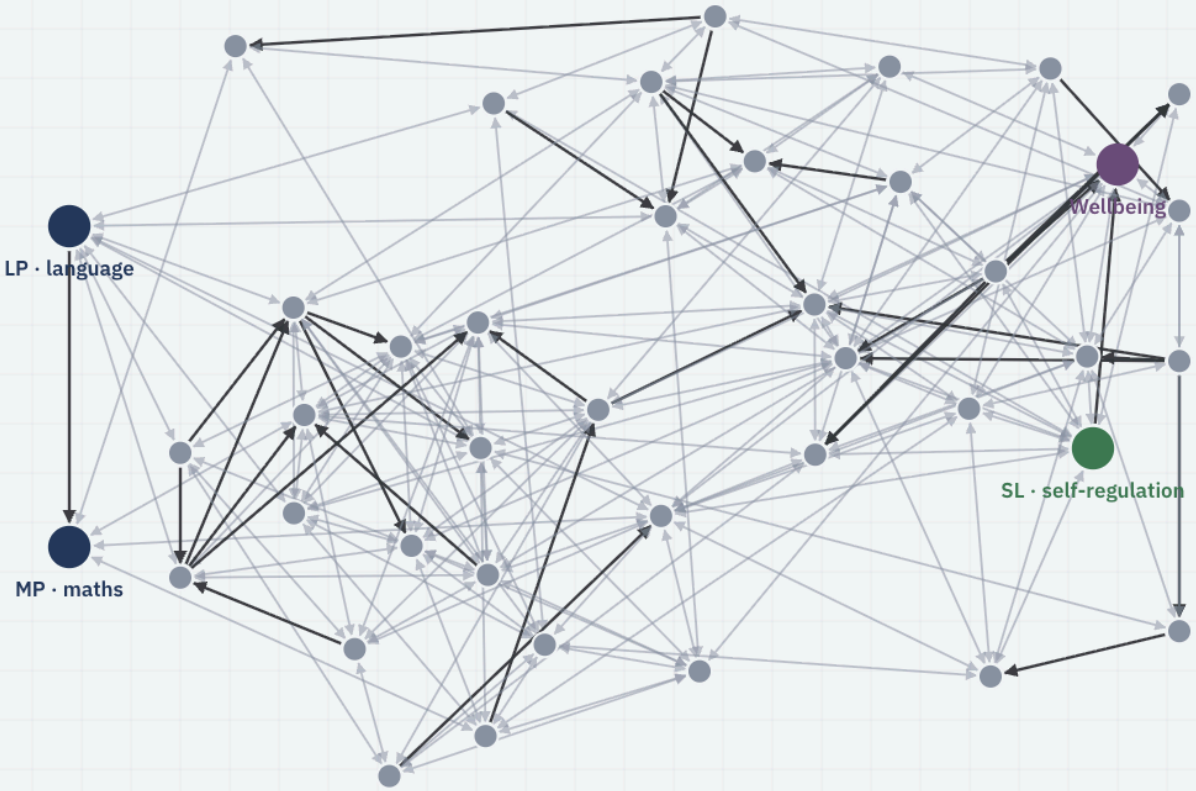
≈ 0%

cluster-aware n* ≈ 5,347: conservative bound

$$n_{\text{eff}} = \frac{(\sum_i w_i)^2}{\sum_i w_i^2} = 13{,}060$$

design effect $\approx 4.93 \times 2.44 \approx 12$

The pruned network

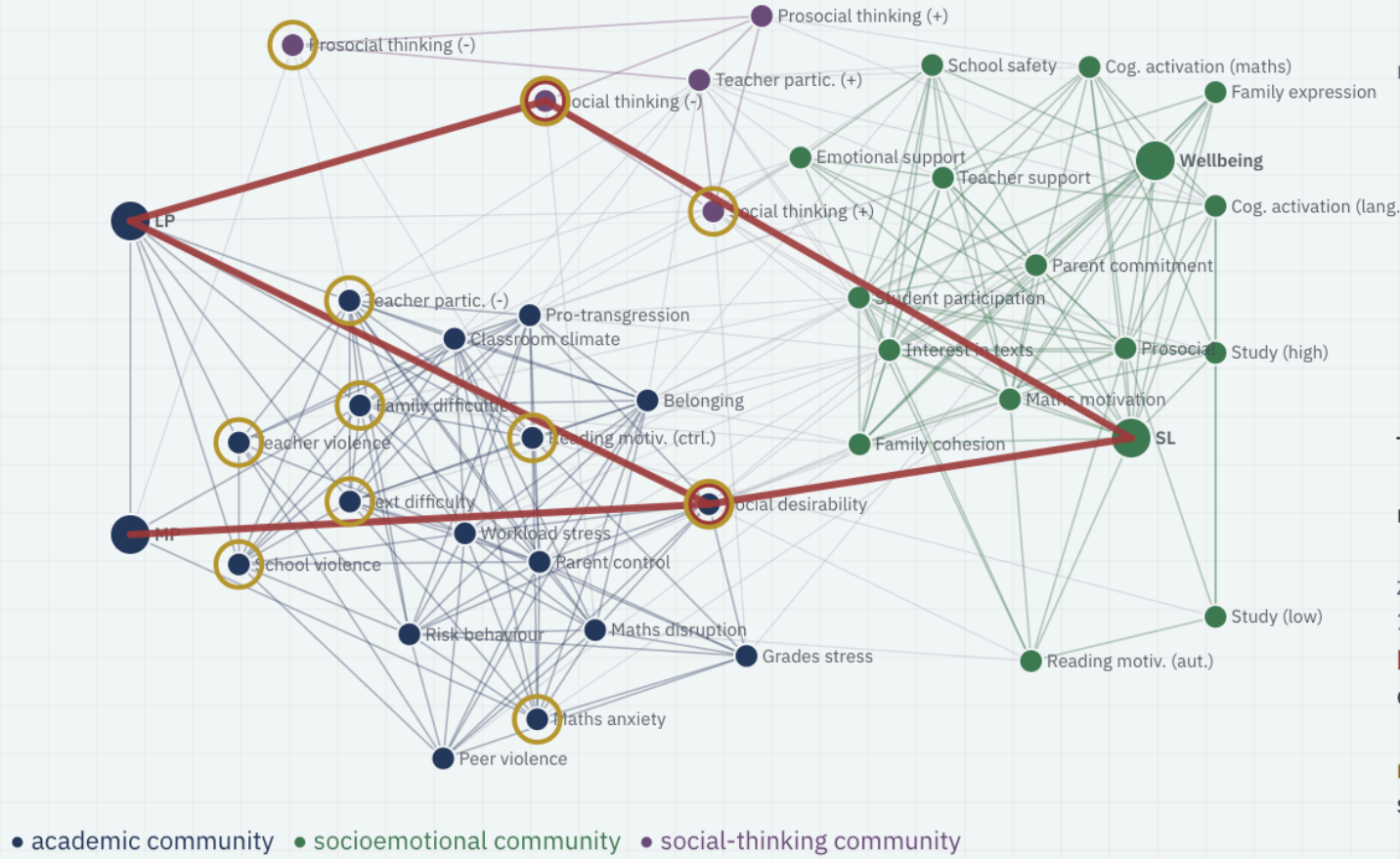


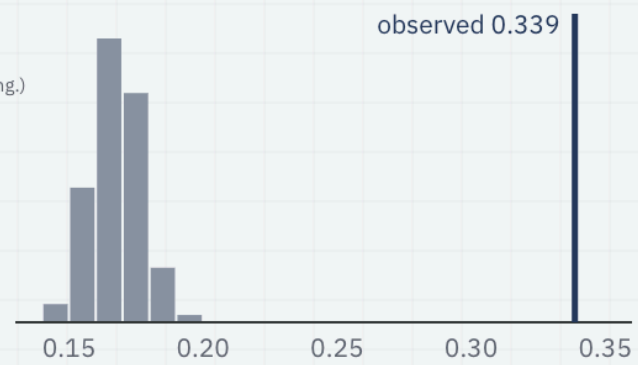
32 directed

162 two-headed (latent cause fits)

RFCI at n_{eff}

The graph as a network





rewired: 0.168 ± 0.009 → z = 19.0

z against rewired networks: PC raw 15.9 · PC n_eff 18.1 · PC n* 14.8 · RFCI n_eff 9.5

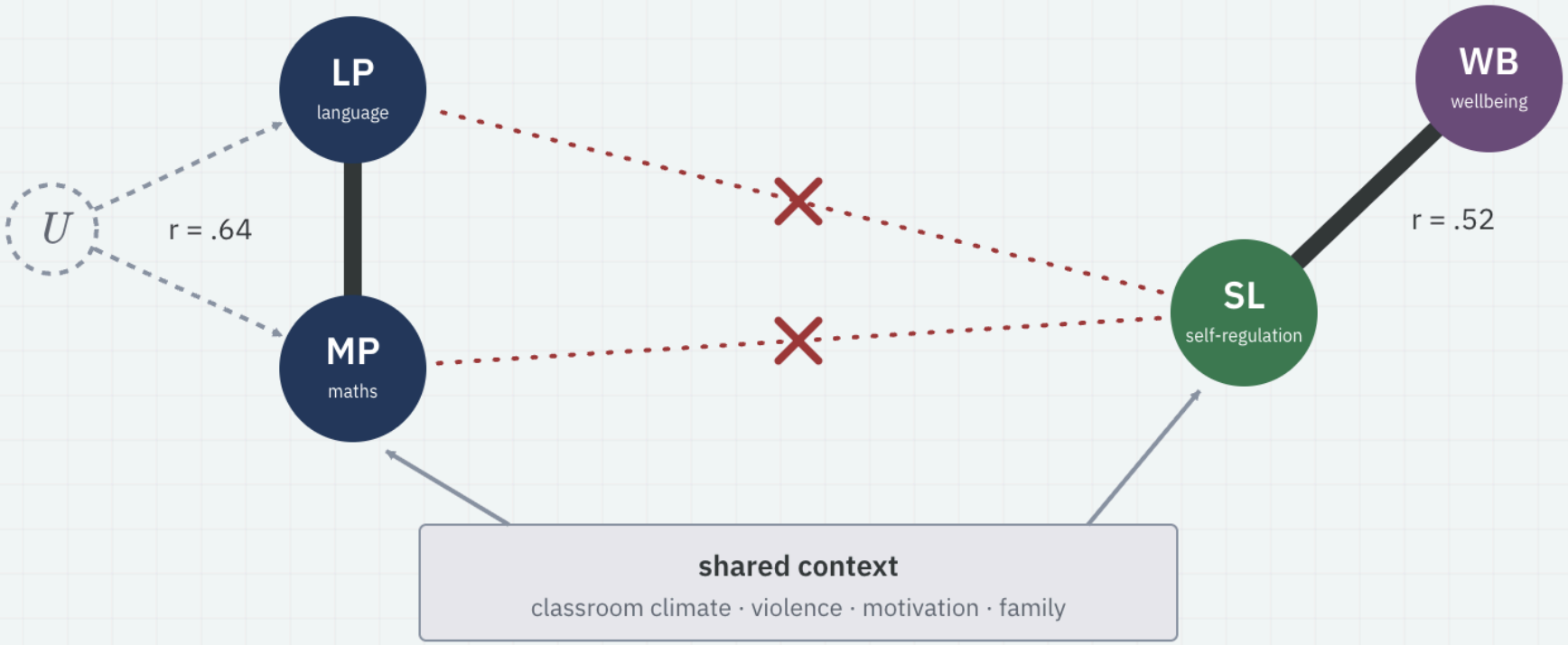
bridges: SL → Social thinking (-) → LP; SL → Social desirability → LP/MP (all two-headed under RFCI)

minimum cut: 11 constructs separate SL from the scores

The three outcomes

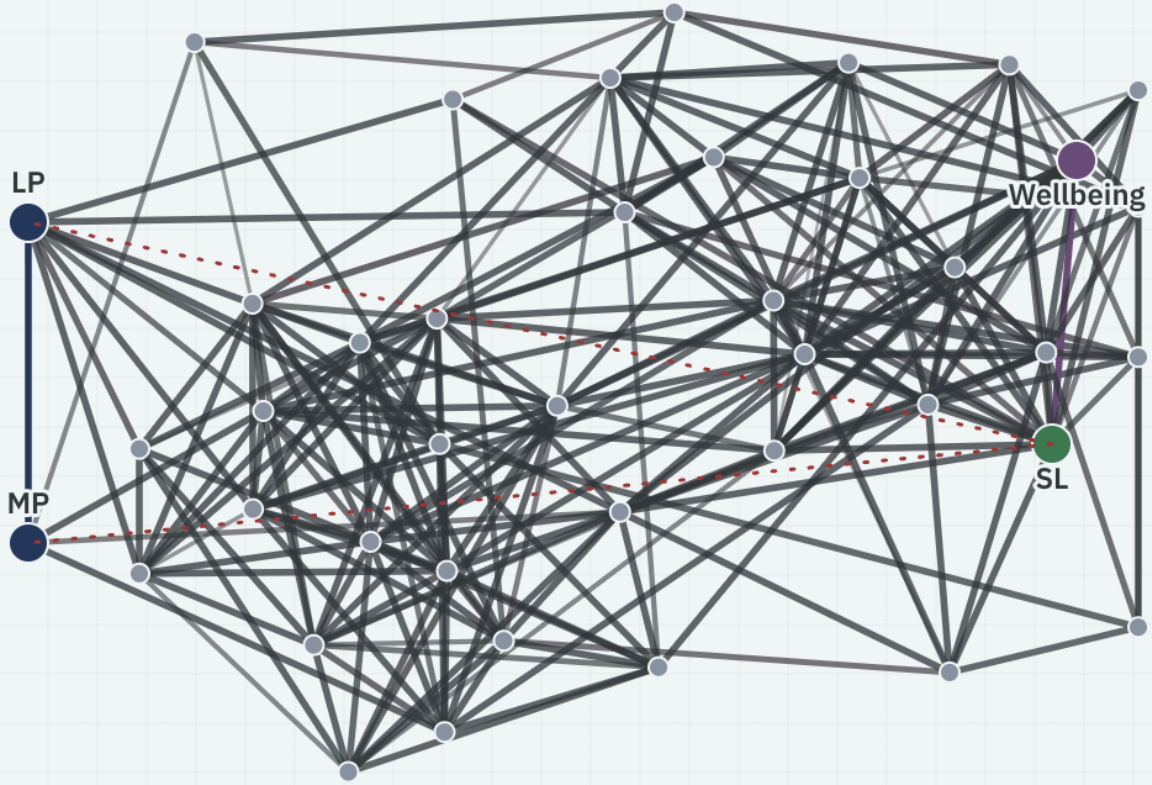
$$\mathrm{SL} \perp \mathrm{MP} \quad (p = .73)$$

$$\mathrm{SL} \perp \mathrm{LP} \mid \mathrm{wellbeing} \quad (p = .18)$$



direction not identified: PC-stable and RFCI orient it in opposite ways; across 200 resamples the orientation splits (RFCI 87% SL → wellbeing, PC 62%)

Two hundred resamples of schools



edge thickness: share of the 200 resamples in which the edge reappears · red dotted: never appears

4,316 schools

one resample: drawn with replacement

×5 ×4 ×2 ×2 ×2 ×2

× 200, the whole pipeline each time

200 / 200 language–maths

0 / 200 self-regulation–score

200 / 200 self-regulation–wellbeing

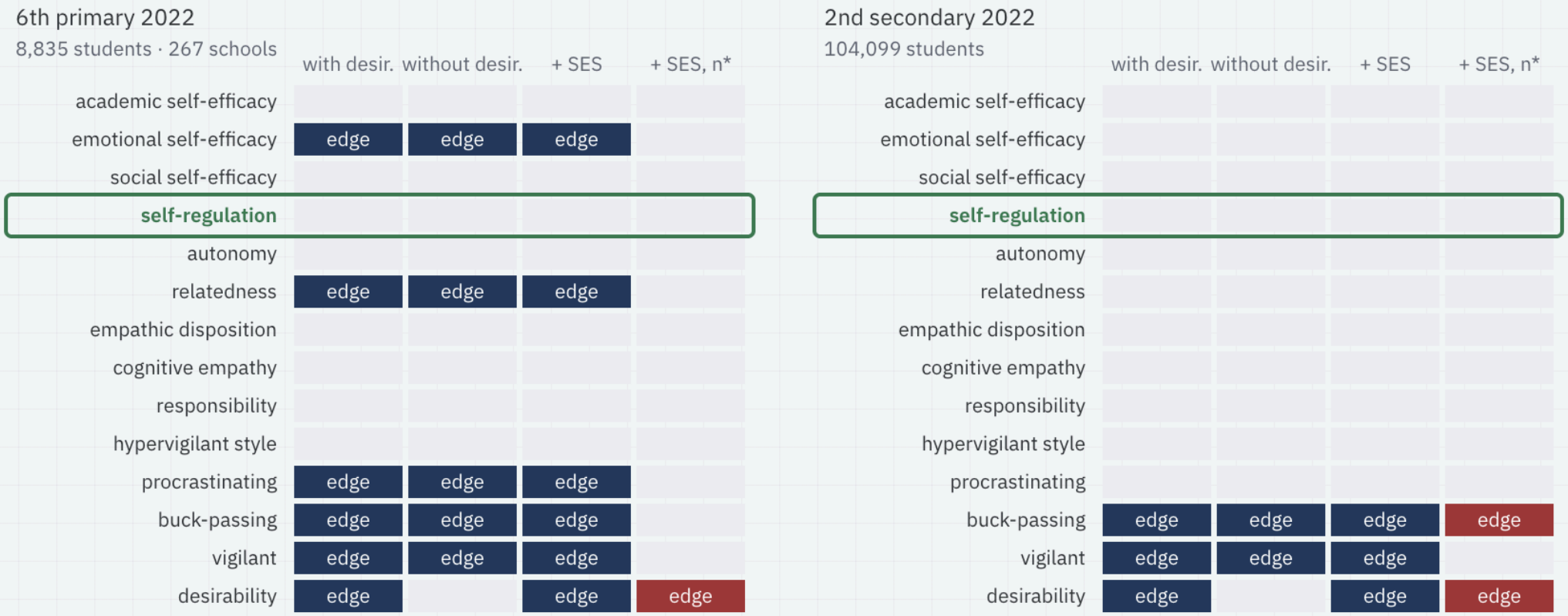
84% of all edges reappear in ≥ 90% of resamples

Eleven treatments of the missing third

		LP–MP adjacent	SL–score edge	SL–wellbeing
Complete cases	64,420 rows	✓	–	✓
Inverse-probability weights	64,420 rows	✓	–	✓
All 97,750 students, pairwise	97,750 rows	✓	–	✓
Rural	13,651 rows	✓	–	✓
Urban	50,769 rows	✓	–	✓
Lowest SES stratum	21,363 rows	✓	–	✓
Other SES strata	35,293 rows	✓	–	✓
State schools	54,072 rows	✓	–	✓
Non-state schools	10,348 rows	✓	–	✓
Amazon departments	11,523 rows	✓	–	✓
Multiple imputation, all students (m = 5)	97,750 rows	✓	–	✓

no = no edge from SL to language or maths

Peru 2022: fourteen constructs



cell: the construct has an edge (PC or RFCI) to language or maths in that run · red: survives the cluster-corrected sample size · n_eff per run: 6P 5,117 / 5,138 / 4,477 / 1,518 · 2S 50,784 / 50,947 / 50,423 / 14,595

self-regulation: no edge to language or maths in any of the eight runs

ERCE 2019: sixteen countries



no direct self-regulation → score edge at n* · edge · not in ERCE 2019

self-regulation → score at n*, and r(self-regulation, language)

Brazil	0.30
Mexico	0.27
Peru	0.24
Guatemala	0.23
Paraguay	0.22
Panama	0.20
Uruguay	0.20
Argentina	0.20
Honduras	0.18
Ecuador	0.17
Nicaragua	0.17
Dominican Rep.	0.16
Cuba	0.13
El Salvador	0.13
Colombia	0.11
Costa Rica	0.09

14 of 16

countries: no direct edge from self-regulation to language or maths at the conservative sample size

Sixteen graphs



What it means

1 **No direct edge from self-regulation to achievement**

0 of 200 resamples · eleven missing-data treatments · total effect within ±0.1 SD · Peru 2022, two grades · 14 of 16 countries

2 **The shared contexts are where the levers are**

classroom climate, violence exposure, motivation, family relations

3 **The finding is specific to self-regulation**

openness to diversity, social desirability and decision styles do connect to the scores

4 **Calibrate the test to the survey design, then resample**

raw n: 39% false alarms · next: link ENLA cohorts across years

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Academic and socioemotional learning in Peru: the dependency structure, allowing for latent confounding

Francisco Richter Mendoza (USI, Lugano) · Elías Aburto Camacllanqui (UNI, Lima) · Kyle Thompson · Pablo Cachaga Herrera (UMSA, La Paz)

data: ENLA 2024 and 2022 (UMC, Ministry of Education of Peru) · ERCE 2019 (UNESCO-LLECE)