Non-cognitive Development and Peer Effect: Experimental Evidence from Chinese Rural Boarding Schools

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Contents

Introduction

Motivation

(a) Rebellion to Adults

(b) Friends

- Motivation 1: providing a substitute for parental companionship
  - A lack of parental companionship might cause emotional and behavioural disorders (Hoeve et al., 2012)
  - Why should we care about Rural boarding schools: overview
- Motivation 2: identifying the peer spillover effect
- Research question: How do peer non-cognitive skills influence an individual's own non-cognitive skills?

This Paper

- The program plays audio-bedtime stories in school dormitories: cleanly separates students into treated and untreated groups within the treatment and control groups
- Treatment effect on board students and spillover effects on day students
- Heterogeneous treatment and spillover effects in relation to social networks
- How average peer non-cognitive skills affect one's non-cognitive skills (treatment and peer's distance from home as IV)

Literature

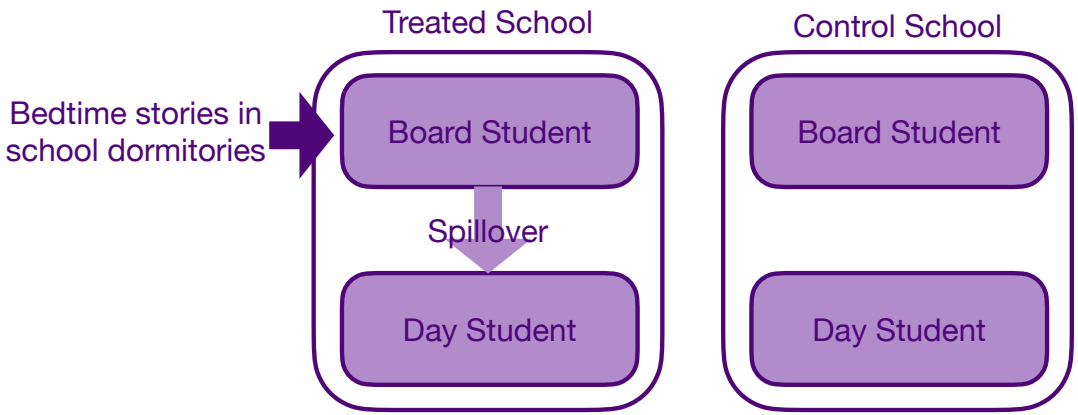
- Basis: Non-cognitive skills exhibit susceptibility to modification through interventions (Shnabel et al., 2013; Cohen and Sherman, 2014; Shan and Zölitz, 2022).
  - Limited examination concerning the spillover effects influencing channels
- Peer effects: Peers' gender, race, or academic achievements, shape the academic performance of individuals and their choices in education (Hoxby, 2000; Figlio, 2007; Sacerdote, 2014).
  - Disagreement on how peer non-cognitive skills affect own non-cognitive skills (Shan and Zölitz, 2022; Bietenbeck, 2021; Boucher et al., 2022)
  - Lack of student network data limited definition of peers to classmates (Feng et al., 2024; Cattan et al., 2023; Garlick, 2018)(Sacerdote, 2001; Carman and Zhang, 2012; Feld and Zölitz, 2017; Zárate, 2023; Hu, 2023)
- Identification challenge: Correlated effects VS real social effects (Manski, 1993, 2013)

The Intervention and Data

The Intervention

- Intervention: The project plays 15-minute bedtime stories through speakers in school dormitories. stories feedback share
- Randomization at the school level: treatment 30; control 33 schools

(a) Listening to Stories



(b) Spillover

- Board students live in school dormitories: direct effects → treatment effect
- Day students go home at night: no direct effects → spillover effect

The Intervention Timeline

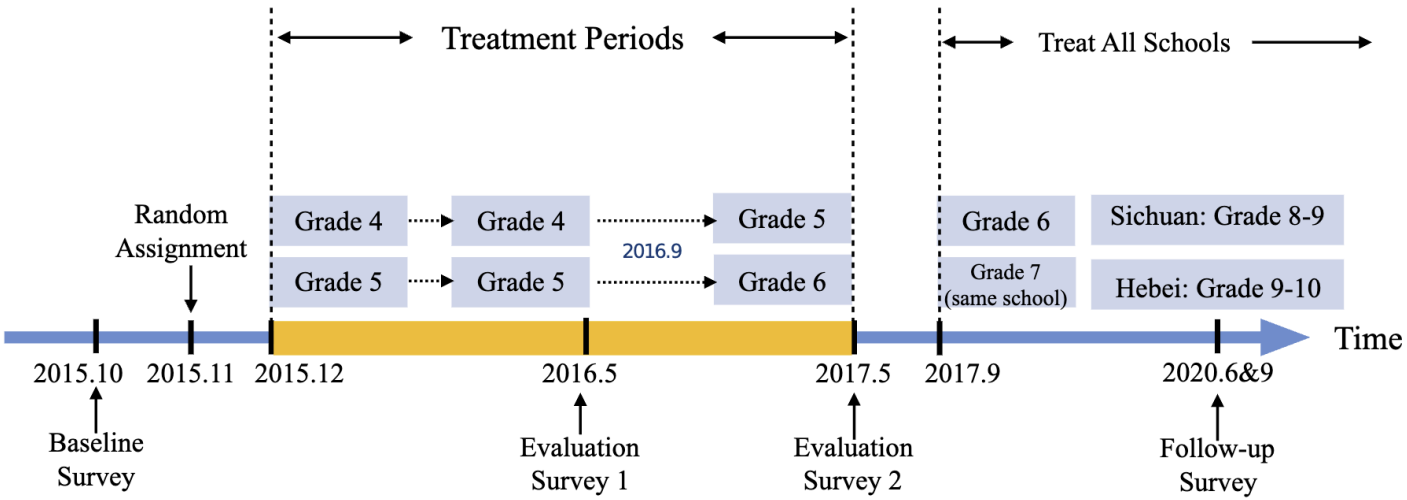


Figure: Timeline

- 6 months(4 months), 18 months(14 months)
- Scaling: 10,039 schools in 948 counties in 29 provinces, 3.99 million children.

Data Descriptive

- Sample characteristics:
  - Sample Distribution distribution
  - Baseline Descriptive

	Variable	Obs	Mean	Std.	Min	Max
Personal characteristics	age	8,236	10.238	0.833	7.280	14.409
	gender	8,236	0.506	0.500	0	1
	grade	8,236	4.500	0.500	4	5
	board	8,236	0.589	0.492	0	1
	left-behind	8,236	0.433	0.496	0	1
	height	8,235	138.805	7.749	112.500	174.000
	weight	8,235	33.160	7.942	17.500	84.200
Family Characteristics	father's education	8,235	8.805	2.098	6	19
	mother's education	8,234	8.314	2.094	6	19
	#siblings	8,236	2.178	0.913	1	8
	Parents' Marriage	8,236	0.119	0.324	0	1
Non-cogtive skills and mental health	Resilience	8,112	128.402	15.002	76.824	171.000
	Self-esteem	8,178	15.712	4.023	0	30
	Internalization	8,143	35.512	7.492	18	70
	Externalization	8,140	28.568	7.721	18	71
	Depression	8,105	19.002	8.918	0	60

- Balance test balance test
- Attrition attrition

Motivating Results

Empirical Strategy

- Estimating equation:

$$Y_{is,t} = \beta_0^k + \beta_1^k T_{s,0} + \sigma^k Y_{is,0} + \gamma^k X_{is,0} + \alpha_c^k + \epsilon_{is,t}^k$$

where $k \in \{\text{day, board}\}$

  - $Y_{is,t}$ represents the factor score of certain outcome for individual i at time t factor analysis
  - $T_{s,0}$ is a treatment indicator that takes on the value 1 if i's school s is assigned to the treatment group
  - $Y_{is,0}$: same outcome measured at baseline
  - $X_{is,0}$: control variables (a set of characteristics at baseline that were imbalanced across treatment and control at t, baseline individual/family characteristics like parent education level etc.)
  - α_c: County fixed effect, SEs clustered at the school level
  - Regressions are run separately for board students and day students

Treatment Effect

	Personal Resilience	Social Resilience	Internalization	Externalization	Self-esteem	Depression
			2016			
Treatment	0.038	0.034	-0.032	-0.015	0.044	0.085**
	(0.053)	(0.053)	(0.045)	(0.037)	(0.050)	(0.037)
P-value	0.479	0.519	0.474	0.695	0.378	0.024
RW p-value	0.847	0.847	0.847	0.847	0.847	0.461
Control Mean	-0.002	-0.003	-0.158	-0.158	-0.014	0.040
Observations	5,055	5,055	4,420	4,488	5,055	4,997
			2017			
Treatment	0.086*	0.074	-0.016	-0.040	0.068	0.004
	(0.049)	(0.048)	(0.054)	(0.052)	(0.047)	(0.040)
P-value	0.084	0.124	0.765	0.444	0.153	0.929
RW p-value	0.373	0.489	0.914	0.847	0.597	0.981
Control Mean	0.043	0.054	-0.112	-0.127	0.041	0.055
Observations	5,084	5,084	4,812	4,836	5,084	5,074

Spillover Effect

	Personal Resilience	Social Resilience	Internalization	Externalization	Self-esteem	Depression
			2016			
Treatment	0.053	0.044	-0.079	-0.068	0.059	-0.015
	(0.056)	(0.054)	(0.063)	(0.050)	(0.055)	(0.051)
P-value	0.340	0.424	0.216	0.177	0.289	0.775
RW p-value	0.712	0.773	0.544	0.557	0.682	0.912
Control Mean	0.092	0.094	-0.259	-0.248	0.077	-0.123
Observations	3,120	3,120	2,729	2,795	3,120	3,093
			2017			
Treatment	0.117*	0.097	0.019	0.046	0.159***	-0.089
	(0.063)	(0.065)	(0.053)	(0.040)	(0.058)	(0.066)
P-value	0.068	0.140	0.727	0.260	0.008	0.187
RW p-value	0.290	0.476	0.912	0.728	0.076	0.515
Control Mean	0.092	0.104	-0.189	-0.243	0.077	-0.072
Observations	2,894	2,894	2,710	2,763	2,894	2,883

Influencing Channel: Friend Network

- The spillover effect are driven by day students who have board friends.
- (1)(2): day students with board friends;
  (3)(4): day students without board friends

	(1) Personal Resilience	(2) Self-esteem	(3) Personal Resilience	(4) Self-esteem
Treatment	0.109*	0.167***	0.085	0.078
	(0.063)	(0.055)	(0.092)	(0.092)
P value	0.090	0.004	0.361	0.404
RW p-value	0.150	0.041	0.350	0.350
Observations	2,017	2,017	877	877

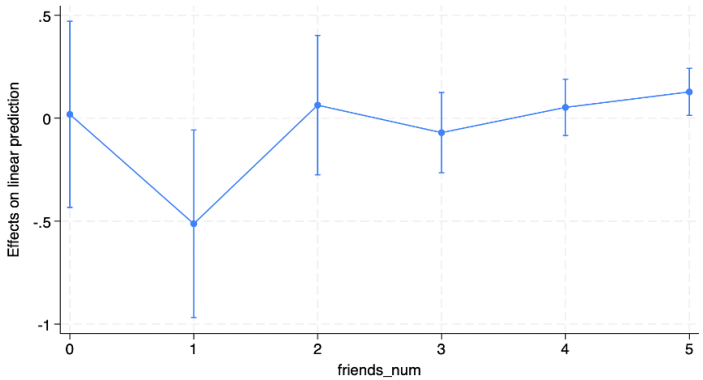
Influencing Channel: Friend Network

- The treatment effect are larger for board students who have day friends/friends.
- (1)(2): board students with day friends;
  (3)(4): board students without day friends
  (5)(6): board students with friends
  (7)(8): board students without friends

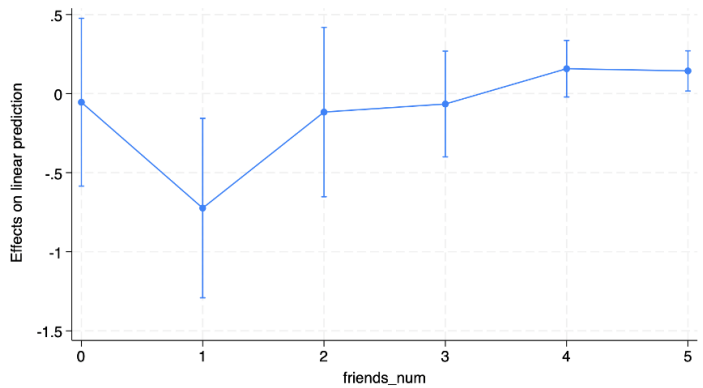
	(1) Personal Resilience	(2) Self-esteem	(3) Personal Resilience	(4) Self-esteem	(5) Personal Resilience	(6) Self-esteem	(7) Personal Resilience	(8) Self-esteem
Treatment	0.115*	0.092	0.048	0.034	0.085*	0.064	-0.145	0.014
	(0.060)	(0.056)	(0.059)	(0.065)	(0.049)	(0.048)	(0.212)	(0.191)
P value	0.060	0.104	0.417	0.599	0.087	0.189	0.498	0.944
RW p-value	0.165	0.312	0.618	0.751	0.120	0.312	0.751	0.942
Observations	2,389	2,389	2,695	2,695	4,947	4,947	138	138

Number of Friends

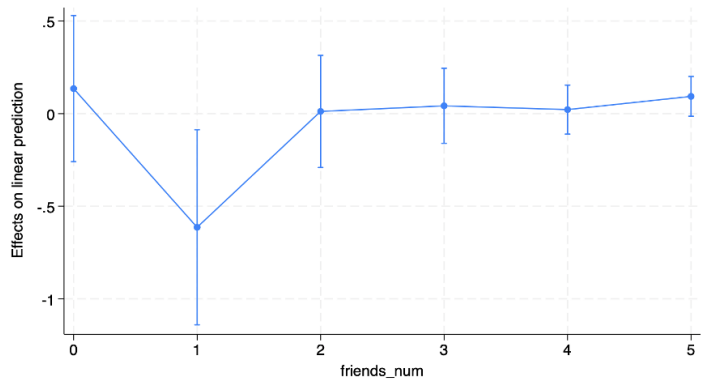
- The more friends a student has, the larger the treatment and spillover effect



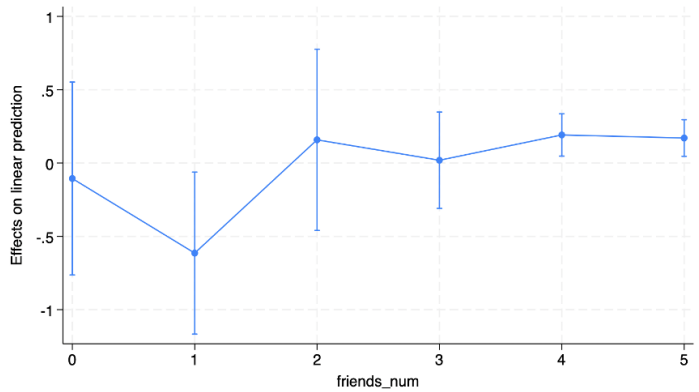
(1) Treatment Effect on Personal Resilience



(2) Spillover Effect on Personal Resilience



(3) Treatment Effect on Self-esteem



(4) Spillover Effect on Self-esteem

No Change in Network Structure

- The treatment did not make a difference to their network structure

	# Board Friends	%Female Friends	# Persistent Friends
Treatment	-0.303	-0.002	-0.179
	(0.204)	(0.005)	(0.241)
After	0.153	0.008	-2.586***
	(0.100)	(0.006)	(0.159)
Interaction	0.079	0.001	0.261
	(0.142)	(0.008)	(0.165)
P-value	0.581	0.899	0.119
RW p-value	0.664	0.891	0.149
Observations	6,297	5,962	6,297

Peer Influence Model

Linear-in-Means Model

- Production function:
  $y_i = x_i\gamma + \lambda\bar{y}_{-i} + \alpha_c + \epsilon_i$ where $\bar{y}_{-i} = \sum_j \tilde{g}_{ij} \cdot y_j$
  - Adjacency matrix $G_{n*n} = [g_{ij}]$: $g_{ij} = 1$ if i nominated j as board friend otherwise 0
  - n_i: number of nominated board friends
  - $\tilde{G}_{n*n} = [\tilde{g}_{ij}]$ where $\tilde{g}_{ij} := g_{ij}/n_i$
  - x_i: gender, age, age square, distance from home, parents' education level
- Instrumental variables:
  - treatment status (T_s)
  - distance from home of their board friends $(\tilde{d}_{-i} = \sum_j g_{ij} D_j)$
- Exclusive restriction: $\mathbb{E}(z_i\epsilon_i) = 0$
  - Treatment: the audio bedtime story treats board students through dormitory speakers so won't directly affect day students
  - Distance from home: board students' distance from home is unlikely to directly affect day students' outcome or their interaction with peers because interaction happens mainly in schools

Linear Model First Stage

- Relevance: $\mathbb{E}(z_i \bar{y}_{-i}) \neq 0 \Rightarrow \bar{y}_{-i} = \alpha_1 x_i + \alpha_2 z_i + \mu_i$

	Personal Resilience	Social Resilience	Self-esteem	Internalization	Externalization	Depression
Treatment	0.129*	0.104	0.128*	-0.003	-0.033	-0.051
	(0.071)	(0.067)	(0.074)	(0.061)	(0.081)	(0.073)
Peer Distance	0.001	0.000	0.000	-0.004	-0.003	-0.000
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)
Cragg-Donald F-statistic	1.990	1.500	1.772	0.396	0.194	0.282
Montiel-Pflueger weak instrument robust F statistic	2.655	1.663	2.473	0.490	0.211	0.307
Observations	1,928	1,928	1,928	1,805	1,853	1,924

LIM IV Estimation

- $z_i \rightarrow \bar{y}_{-i} \rightarrow y_i$

	(1)	(2)	(3)	(4)	(9)	(10)	(11)	(12)
	Personal Resilience				Self-esteem			
	2SLS	GMM	LIML	Fuller	2SLS	GMM	LIML	Fuller
Average Peer Influence	0.975**	0.893*	1.062*	0.995**	1.345	1.386**	1.441**	1.343**
	(0.489)	(0.466)	(0.573)	(0.508)	(0.643)	(0.661)	(0.741)	(0.641)
Overidentifying test statistic	1.393	1.447	1.352	1.080	1.026	0.921	0.990	0.704
Overidentifying test P-value	0.248	0.229	0.245	0.299	0.311	0.337	0.320	0.401
Observations	1,928	1,928	1,928	1,928	1,928	1,928	1,928	1,928

Conclusion

- There is a positive spillover effect on personal resilience and self-esteem from the treated to their untreated peers within the treatment group.
- The friendship network is the key channel influencing these effects. Students with more treated friends or with more friends gain more from the intervention.
- A 1 standard deviation (SD) increase in the average personal resilience or self-esteem of nominated friends leads to an increase of approximately 0.9-1 SD in personal resilience and 1.35-1.45 SD in self-esteem for an individual.

Thank you!

Overview

- 5 National-level poverty-stricken counties (out of 832 in total)
- The average education level is between primary and junior high school.
- Our sample: 46% left-behind, 70% never heard a bedtime story from parents

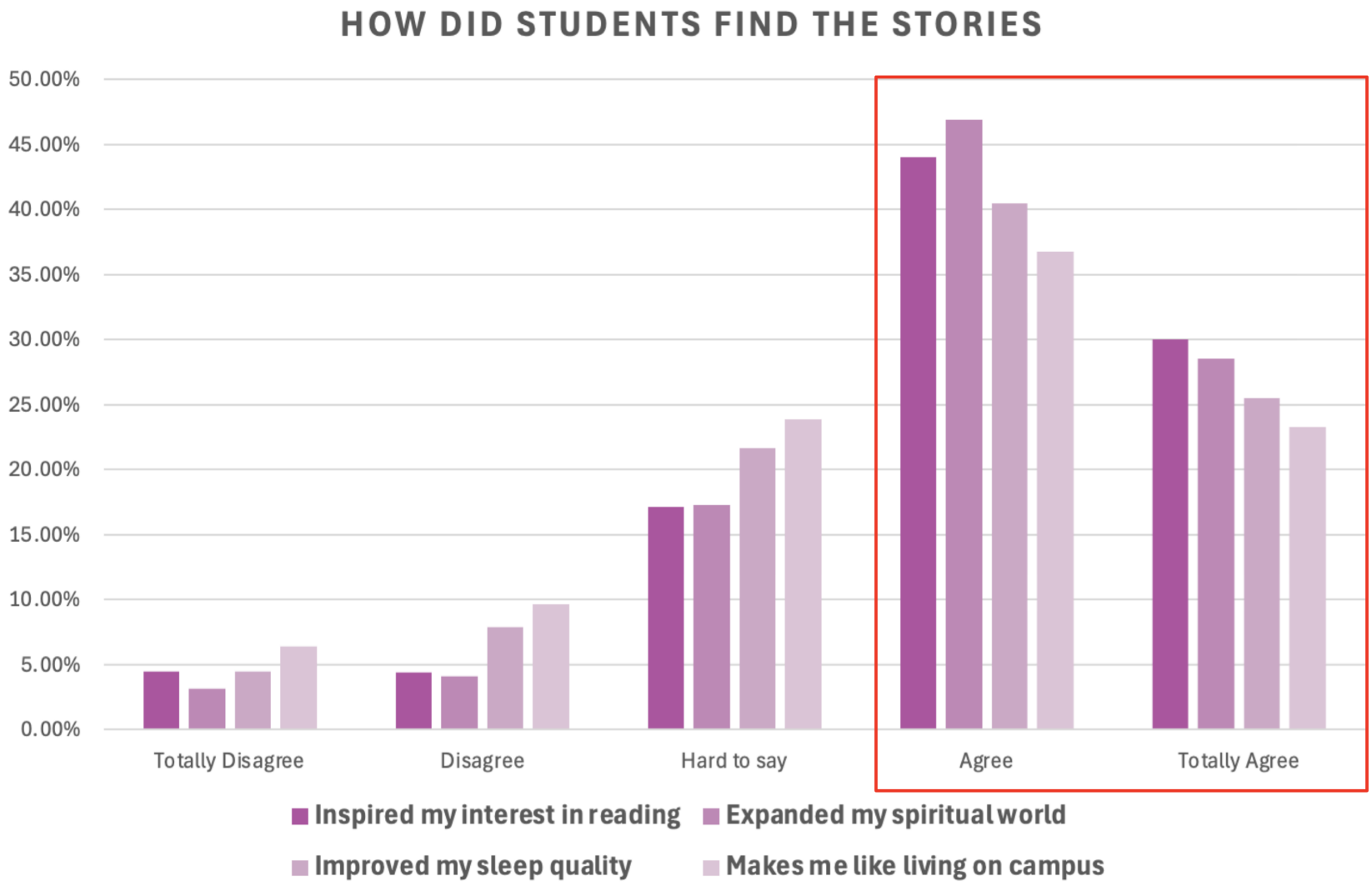
	All	Sichuan Province	Hebei Province	Cangxi County	Wangcang County	Zhuolu County	Guyuan County	Yu County
	2015							
GDP per capita (Yuan)	49,922	37,150	35,994	18,738	21,897	27,408	25,546	17,481
Per capita disposable income of rural residents (Yuan)	11,422	10,247	11,051	9,048	9,016	9142	7305	7,445
	2020							
GDP per capita (Yuan)	71,828	58,009	48,302	35,041	42,088	30,659	41,060	20,413
Per capita disposable income of rural residents (Yuan)	17,131	16,467	15,929	14,532	14,429	15,792	12,951	12,803
Yeas of education	9.91	9.24	9.84	7.84	8.54	9.07	8.51	8.87

Bedtime Story Example

The representative most frequently-played stories in 2023: back

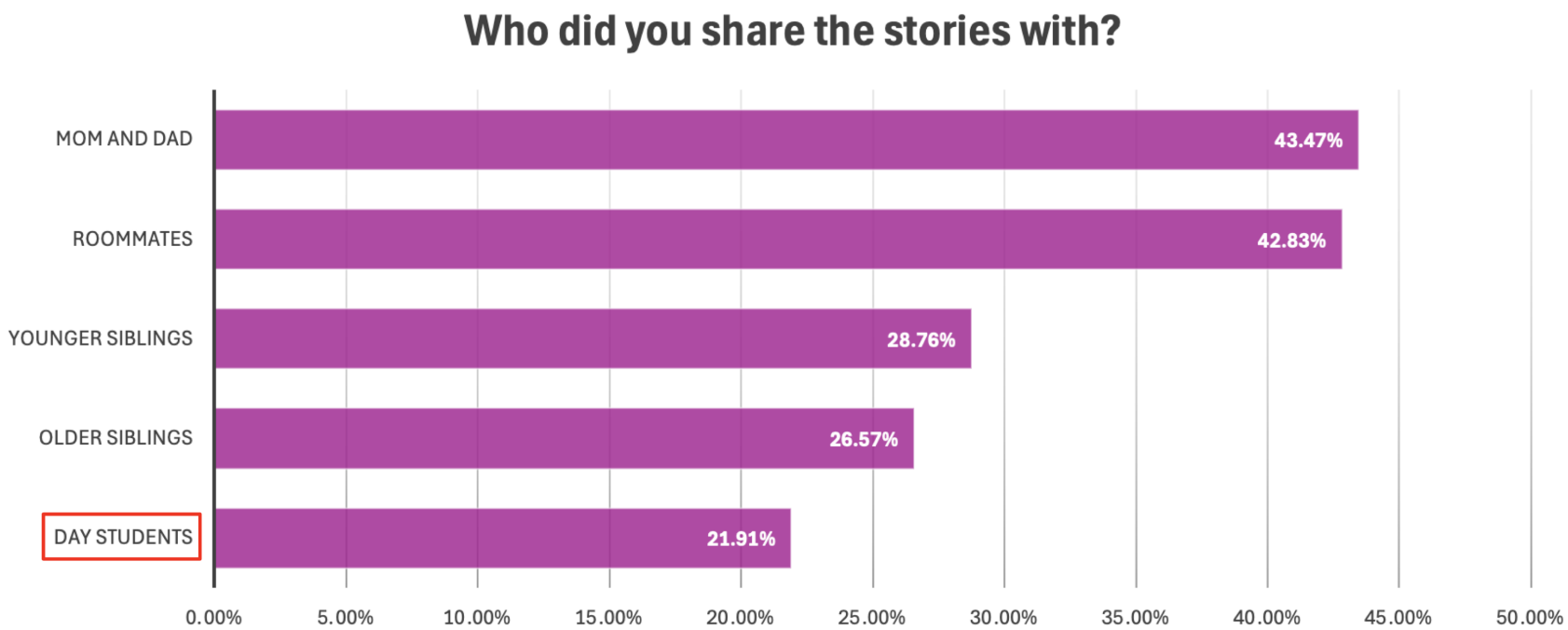
- **That's Not a Hippo:** At the zoo, children and their teacher search for a lost hippo. Amidst the confusion, Liam persistently points out the real hippo, leading to a joyful find. [Animal, Nature]
- **The Wheelchair-bound Young Innovator:** Confined to a wheelchair by illness, teenager Chen Zipeng transcends his physical limits by clinching top innovation awards. His creations, a "smart mousetrap" and "smart stray pet feeder," earned him first prizes at national IT competitions and the World Internet of Things Expo. [Strength, Innovation]
- **Scarborough Fair:** weaves a poignant story of a soldier's love lost to war, his memory living on in a herb-filled village—a symbol of undying affection, a serene hymn to life's preciousness, and peace's gentle pursuit, radiating love's pure glow. [Love, Peace, Antiwar]

How Did the Students Find the Stories?



back

Did the Students Share the Stories to Others?



back

Randomization

	Schools	Observations
Audio Story	30	3,911
Book	30	3,673
Audio and Book	29	3,868
Control group	33	4,325
Control county	15	2,021
In total	137	17,798

data

Balance Test

	Board Student			Day Student		
	Control	Treat	P-value/ RW p-value	Control	Treat	P-value/ RW p-value
Personal Characteristics:						
Age	10.316	10.266	0.610	10.146	10.108	0.757
	(0.828)	(0.866)	[0.979]	(0.798)	(0.792)	[0.985]
Gender	0.529	0.517	0.550	0.443	0.499	0.004
	(0.499)	(0.500)	[0.997]	(0.497)	(0.500)	[0.719]
Grade	4.527	4.512	0.650	4.461	4.456	0.844
	(0.499)	(0.500)	[0.996]	(0.499)	(0.498)	[1.000]
Height	138.912	138.810	0.912	139.078	138.316	0.387
	(7.701)	(7.885)	[1.000]	(7.740)	(7.606)	[0.823]
Weight	33.367	32.844	0.528	33.555	32.911	0.521
	(8.293)	(7.344)	[0.960]	(8.635)	(7.489)	[0.873]
Left-behind	0.430	0.456	0.627	0.408	0.423	0.788
	(0.495)	(0.498)	[0.981]	(0.492)	(0.494)	[0.989]
Family Characteristics:						
Mother's Education	8.137	8.111	0.837	8.587	8.794	0.213
	(2.004)	(2.067)	[1.000]	(2.118)	(2.201)	[0.823]
Father's Education	8.605	8.618	0.906	8.998	9.370	0.026
	(2.013)	(2.027)	[1.000]	(2.192)	(2.187)	[0.565]
Parents' Marriage	0.134	0.130	0.087	0.098	0.440	0.465
	(0.341)	(0.337)	[1.000]	(0.281)	(0.297)	[0.989]
Outcome Variables:						
Resilience	-0.015	0.002	0.780	0.046	0.046	0.999
	(0.996)	(0.956)	[1.000]	(1.003)	(0.971)	[1.000]
Self-esteem	-0.374	-0.339	0.427	-0.382	-0.376	0.883
	(0.909)	(0.865)	[0.996]	(0.866)	(0.897)	[1.000]
Sleeping quality	35.859	35.785	0.746	34.871	34.782	0.792
	(5.120)	(4.929)	[1.000]	(5.302)	(5.137)	[1.000]
Depression	0.024	0.074	0.417	-0.114	-0.127	0.858
	(1.000)	(0.983)	[0.981]	(0.978)	(0.958)	[1.000]
Math	0.185	0.125	0.100	0.154	0.376	0.025
	(0.827)	(0.804)	[0.960]	(0.815)	(0.709)	[0.193]
Reading	-0.402	-0.428	0.750	-0.435	0.022	0.383
	(0.816)	(0.779)	[0.996]	(0.807)	(0.757)	[0.849]
# friends	4.030	3.795	0.482	4.115	3.914	0.398
	(1.362)	(1.695)	[0.689]	(1.256)	(1.573)	[0.713]

data

Attrition

- Attrition is not related to treatment status

	Board Student	Day Student	Board Student	Day Student
2016	0.244	0.758	0.154	0.569
	[0.284]	[0.787]	[0.295]	[0.823]
2017	0.000	0.138	0.000	0.054
	[0.001]	[0.333]	[0.001]	[0.184]
2020	0.151	0.368	0.531	0.713
	[0.284]	[0.625]	[0.504]	[0.823]
Control	No	No	Yes	Yes

- Attrition is not related to baseline outcomes

	Attrition (Day students)	Attrition (Board students)
	(2)	(3)
Cohort's Personal Resilience	-0.017	0.005
	(0.031)	(0.024)
Cohort's Social Resilience	0.016	0.006
	(0.022)	(0.018)
Cohort's Internalization	-0.010	0.003
	(0.007)	(0.008)
Cohort's Externalization	0.007	0.002
	(0.008)	(0.008)
Cohort's Self-esteem	0.011	-0.001
	(0.013)	(0.011)
Cohort's Depression	0.007	0.008
	(0.005)	(0.006)
Observations	2,374	3,342
County FE	Yes	Yes
Other controls	Yes	Yes

Measurement

$$Z_{ij}^* = v_j + \lambda_j^\top Y_i + u_{ij}.$$

$$Z_{ij} = s \quad \text{if} \quad \tau_{s,j} \geq Z_{ij}^* \geq \tau_{s+1,j} \quad \text{for} \quad s = 1, 2, 3, 4$$

with $\tau_{1,j} = -\infty$ and $\tau_{4,j} = \infty$

- Y_i: latent factors
- Z_{ij}: available measures (1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree, ordered in the same direction)
- v_j: item-specific intercepts
- λ_j: loadings
- u_{ij}: independent measurement error term
- τ_j: item- and group-specific threshold parameters

$$Y_i \sim \mathcal{N}\left(\kappa, \sigma_Y^2\right) \quad \text{and} \quad u_{ij} \sim \mathcal{N}\left(0, \sigma^2\right).$$

- normalization: $k = 0, \sigma_Y^2 = 1, v_j = 0, \sigma^2 = 1$
- Factor scores not orthogonal: a dedicated factor structure (from EFA) based on the oblique factor rotation matrix (oblimin)

back

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