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Parents Can Tell!
Evidence on Classroom Quality Differences in German Primary Schools

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I. Introduction

- In the last 20 years → growing literature on the determinants and economic value of teacher effects or value-added, but very little evidence from Germany
- **We estimate the individual teacher-classroom effects on student math and language competence development in German primary schools** using data from German National Educational Panel Study (NEPS) SC2 (1st and 2nd grades).
- **We find substantial individual classroom effects on math and language** (classroom quality differences).
- **Classroom effects are not explained by observed teacher characteristics**.
- **Parental assessment of teacher quality** is the only indicator that significantly explains the classroom effects on language.
- **Possible association of classroom effects with later outcomes** (tracking)

II. Teacher and Classroom Effects: Conceptual Framework

Teacher effect → individual teacher contribution to student learning estimated with **value-added models (VAM):**

- Derived from the education production function literature (Hanushek, 1971; 1979; Todd and Wolpin, 2003)
- **VAM specifications** → lagged achievement measure is included and taken to be a **sufficient proxy for unobserved input histories** (family, classroom and school) as well as **unobserved endowment of mental capacity** (ability)
- Potential of providing **unbiased education production function estimates**
- **Critics and controversy** → VAM teacher estimates biased if non-random assignment of students to teachers based on unobserved factors

II. Teacher and Classroom Effects: Empirical Research

Vast and consistent research on teacher effects (VA) in the U.S. (E. A. Hanushek and Rivkin 2012; Rivkin, Hanushek, and Kain 2005; E. A. Hanushek and Rivkin 2006; Jackson, Rockoff, and Staiger 2014; Nye, Konstantopoulos, and Hedges 2004; Rockoff 2004; Chetty, Friedman, and Rockoff 2014; Aaronson, Barrow, and Sander 2007):

- **Substantial teacher effects (VA)** or individual contribution to student achievement, **but also substantial variation.**
- **Little evidence** that teacher **observable characteristics** are **strongly related to teacher effects.**
- Access to **high value-added teachers positively affect short-term academic success** (test scores) and **later-life outcomes** (wage, college attendance).
- **Discriminates** between the **persistent teacher effect** (at least two classrooms per teacher), and the **teacher-classroom effect** or **classroom effect** (one year of classroom data per teacher).

III. Research Questions and Contributions

- ✓ **How large are classroom effects (quality differences) in German primary schools?**
- ✓ **What teacher qualifications explain these effects?**
- ✓ **Are there parental behavioral responses to perceived teacher-classroom quality?**
- ✓ **Does access to higher value-added classrooms in primary school affect later-educational outcomes?**

IV. Data

National Educational Panel Study (NEPS), Starting Cohort 2 (SC2), 1st and 2nd grades:

- Students have not yet been sorted into type of school based on their abilities or socioeconomic status (no tracking)
- Rich information on:
  - **Competence tests**: math (two consecutive waves) and language (early reading/grammar), time between tests.
  - **Student characteristics**: gender, age migration background
  - **Household characteristics:** highest years of education, highest ISES, siblings.
  - **Teacher characteristics**: gender, experience, *Abitur* GPA, First and Second State Exam grades, migration background, constructivist beliefs, exhaustion, parental evaluation
- Sample restricted to observations taught by the same teacher in g1 and g2 (66% from g1).

IV. Data and Descriptive Statistics

	Full sample (1)	Math: Dropout sample (2)	Math: Analysis sample (3)	Math: Norm Diff (5)	Language: Dropout sample (6)	Language: Analysis sample (7)	Language: Norm Diff (9)
Competence measures							
G1: Math (WLE)	0.04	-0.09	0.19	0.19	-0.10	0.21	0.20
	(1.09)	(1.11)	(1.06)		(1.10)	(1.06)	
G2: Math (WLE)	0.05	-0.06	0.19	0.16	-0.07	0.22	0.18
	(1.15)	(1.15)	(1.13)		(1.14)	(1.13)	
G1: Grammar (WLE)	0.05	-0.09	0.22	0.23	-0.08	0.23	0.23
	(0.97)	(0.96)	(0.95)		(0.96)	(0.95)	
G2: Early reading (Std)	0.02	-0.08	0.15	0.17	-0.08	0.15	0.16
	(0.98)	(0.96)	(1.00)		(0.96)	(1.00)	
Child demographics							
Age [Months]	92.67	92.82	92.46	0.05	92.78	92.51	0.06
	(4.48)	(4.62)	(4.27)		(4.64)	(4.22)	
Female	0.51	0.51	0.53	0.03	0.50	0.53	0.03
	(0.50)	(0.50)	(0.50)		(0.50)	(0.50)	
Migration background	0.20	0.22	0.19	-0.06	0.21	0.19	-0.06
	(0.40)	(0.41)	(0.39)		(0.41)	(0.39)	
Parental background							
Years of education	15.00	14.83	15.15	0.12	14.80	15.20	0.14
	(2.30)	(2.32)	(2.28)		(2.33)	(2.26)	
ISEI	59.56	57.93	61.01	0.14	57.63	61.47	0.16
	(19.00)	(19.21)	(18.70)		(19.23)	(18.58)	
Number of siblings	1.14	1.15	1.13	-0.01	1.15	1.13	-0.01
	(0.87)	(0.89)	(0.85)		(0.89)	(0.85)	
Number of Students	4564	2721	1843		2811	1753	

Data: NEPS SUF, SC2 8.0.1, own calculations.

IV. Data and Descriptive Statistics

		Math			Language		
Teacher	Full sample (1)	Dropout sample (2)	Analysis sample (3)	Norm Diff (5)	Dropout sample (6)	Analysis sample (7)	Norm Diff (9)
Female	0.93	0.94	0.93	-0.05	0.94	0.93	-0.05
	(0.25)	(0.24)	(0.26)		(0.24)	(0.26)	
Age	46.02	45.38	47.09	0.10	45.56	46.85	0.08
	(10.73)	(10.85)	(10.47)		(10.91)	(10.39)	
Experience	20.38	19.53	21.77	0.08	19.76	21.45	0.05
	(11.50)	(11.59)	(11.23)		(11.69)	(11.10)	
Has *Abitur*	0.94	0.93	0.94	0.02	0.93	0.95	0.02
	(0.24)	(0.25)	(0.23)		(0.25)	(0.23)	
Abitur GPA	2.46	2.48	2.41	-0.09	2.48	2.40	-0.11
	(0.52)	(0.53)	(0.49)		(0.53)	(0.50)	
FSE grade	1.99	1.99	1.98	-0.02	2.00	1.96	-0.08
	(0.47)	(0.49)	(0.42)		(0.49)	(0.43)	
Passed SEE	0.84	0.87	0.80	-0.08	0.87	0.80	-0.08
	(0.36)	(0.34)	(0.40)		(0.34)	(0.40)	
SEE grade	1.93	1.93	1.93	-0.02	1.95	1.90	-0.08
	(0.57)	(0.59)	(0.55)		(0.59)	(0.54)	
Migration background	0.05	0.04	0.06	0.10	0.04	0.07	0.11
	(0.22)	(0.20)	(0.25)		(0.20)	(0.25)	
Constructivist beliefs	3.38	3.38	3.38	-0.02	3.38	3.38	-0.01
	(0.39)	(0.39)	(0.39)		(0.39)	(0.38)	
Exhaustion	2.99	3.05	2.89	-0.10	3.05	2.89	-0.10
	(1.04)	(1.00)	(1.11)		(1.00)	(1.11)	
Parental evaluation	3.59	3.59	3.60	0.04	3.58	3.61	0.05
	(0.36)	(0.41)	(0.26)		(0.41)	(0.26)	
Class size	21.92	21.70	22.27	0.18	21.76	22.20	0.16
	(3.42)	(3.33)	(3.55)		(3.34)	(3.55)	
Number of Teachers	680	429	251		440	240	

Data: NEPS SUF, SC2 8.0.1, own calculations.

V. Estimation Strategy

1. **Adjusted Classroom Fixed Effects:** average residuals VAM

$$Y_{isjt} = \alpha_o + Y_{isjt-1}\beta_1 + X_{isjt}\beta_2 + C_{isjt}\beta_3 + n_{isjt}$$
$$n_{isjt} = \theta_{sjt} + e_{isjt}$$

Subsequent Empirical Bayes (EB) shrinkage of θ

2. **Classroom Random Effects:** VA multilevel or mixed model

$$Y_{isjt} = \alpha_o + Y_{isjt-1}\beta_1 + X_{isjt}\beta_2 + C_{isjt}\beta_3 + \zeta_{sjt} + \epsilon_{isjt},$$

Direct EB prediction to estimate the random intercepts ζ_{sjt}

- Y_{isjt}: competence of student *i* at school *s* with teacher *j* in year *t (math, language, science)*
- αo: state fixed effects
- X_{isjt}: vector of student and family characteristics; C_{isjt}: vector classroom characteristics (averages)
- θ_{isjt}: vector teacher-classroom individual dummies (teacher fixed effect)
- ζ_{sjt}: vector teacher-classroom random effects

V. Estimation Strategy

Empirical Bayes Adjustment

- **Empirical Bayes (EB) shrinkage** implemented to adjust the classroom effect estimates by their level of precision.
- The adjusted estimate is a weighted average of the classroom's initial VA and the VA of an average teacher → **more precise estimates receiving greater weight than less precise estimates (fewer students)**

$$\hat{\theta}_j^{EB} \approx \left(\frac{\hat{\sigma}^2}{\hat{\sigma}^2 + \hat{\sigma}_j^2} \right) \hat{\theta}_j$$

Where:

- $\hat{\theta}_j$: pre-shrinkage point estimate for teacher from the value-added regression model
- $\hat{\sigma}_j^2$: heteroskedasticity-robust variance estimate of $\hat{\theta}_j$
- $\hat{\sigma}$: estimate of the s.d. of teacher effects (purged of sampling error)

V. Estimation Strategy

Identification: e_{isjt}/ϵ_{isjt} expected to be uncorrelated to the classroom effect in German primary schools.

1. **Matching of students to teachers not prevalent in primary school in Germany** → no tracking and children must attend to nearest public school.
2. **Teachers are centrally allocated to schools at the federal state level**, based on the teaching subjects required at the school.
3. **Baseline performance** empirically seems to be a sufficient statistic for unobserved student and family histories as well as unobserved endowment of mental capacity or ability.

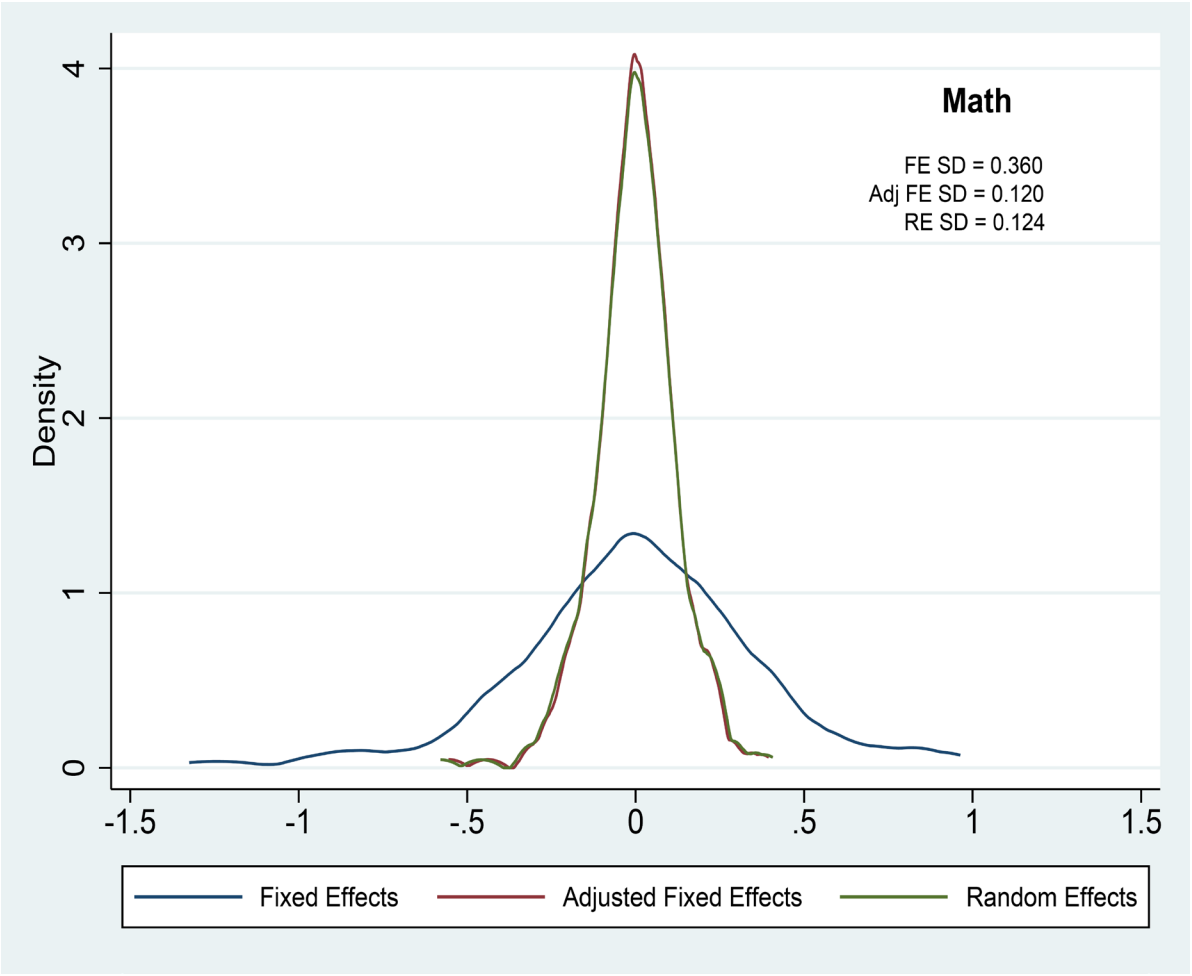
V. Estimation Strategy

Random Assignment Check (g2)

	Teacher						
	Gender (1)	Experience (2)	Abitur GPA (3)	FSE grade (4)	SSE passed (5)	SSE grade (6)	Constructivist beliefs (7)
Child competences:							
Lagged Math	0.002	0.021	-0.007	-0.001	-0.002	-0.002	0.004
	(0.005)	(0.201)	(0.010)	(0.009)	(0.008)	(0.012)	(0.018)
Lagged Scientific	0.002	-0.064	-0.010	-0.006	-0.016	0.010	-0.009
	(0.007)	(0.271)	(0.013)	(0.012)	(0.010)	(0.015)	(0.028)
Lagged Grammar	-0.008*	-0.284	0.014	-0.005	0.009	-0.009	-0.005
	(0.004)	(0.238)	(0.013)	(0.011)	(0.009)	(0.011)	(0.019)
Child demographics:							
Age (months)	0.001	0.012	0.001	0.000	0.003**	-0.003	-0.003
	(0.001)	(0.044)	(0.002)	(0.002)	(0.001)	(0.002)	(0.004)
Female	0.019**	0.389	-0.021	-0.010	0.010	-0.005	0.010
	(0.008)	(0.295)	(0.016)	(0.014)	(0.011)	(0.017)	(0.028)
Migration background	0.014	0.731	0.058*	-0.014	0.061***	-0.001	-0.060
	(0.010)	(0.480)	(0.034)	(0.021)	(0.020)	(0.026)	(0.045)
Parental background:							
Years of education	-0.001	0.206*	-0.001	0.008*	-0.003	0.006	0.005
	(0.002)	(0.109)	(0.006)	(0.004)	(0.004)	(0.006)	(0.008)
ISEI	0.000	0.002	0.001	-0.001*	0.001**	-0.000	0.000
	(0.000)	(0.013)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Siblings	0.005	-0.272	-0.015	0.013*	-0.001	0.023**	-0.004
	(0.004)	(0.208)	(0.010)	(0.007)	(0.007)	(0.011)	(0.018)
Constant	0.930***	8.772*	1.578***	1.054***	0.674***	1.288***	0.138
	(0.110)	(4.572)	(0.201)	(0.179)	(0.151)	(0.223)	(0.434)
Number of students	2920	2485	1993	2091	2554	1998	2672
R^2	0.583	0.666	0.675	0.645	0.607	0.664	0.653
F	1.57	1.43	0.99	1.16	2.59	0.84	0.50
p	0.124	0.174	0.446	0.322	0.007	0.577	0.875

*Data: NEPS SUF, SC2 8.0.1, own calculations. Notes: OLS regressions estimated with school fixed effects. Standard errors (in parentheses) clustered at the school level. Total number of observation correspond to the full sample of students whose teachers provided the respective information on their characteristics. * Significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level. Data*

VI. Results: Classroom Effects on Math



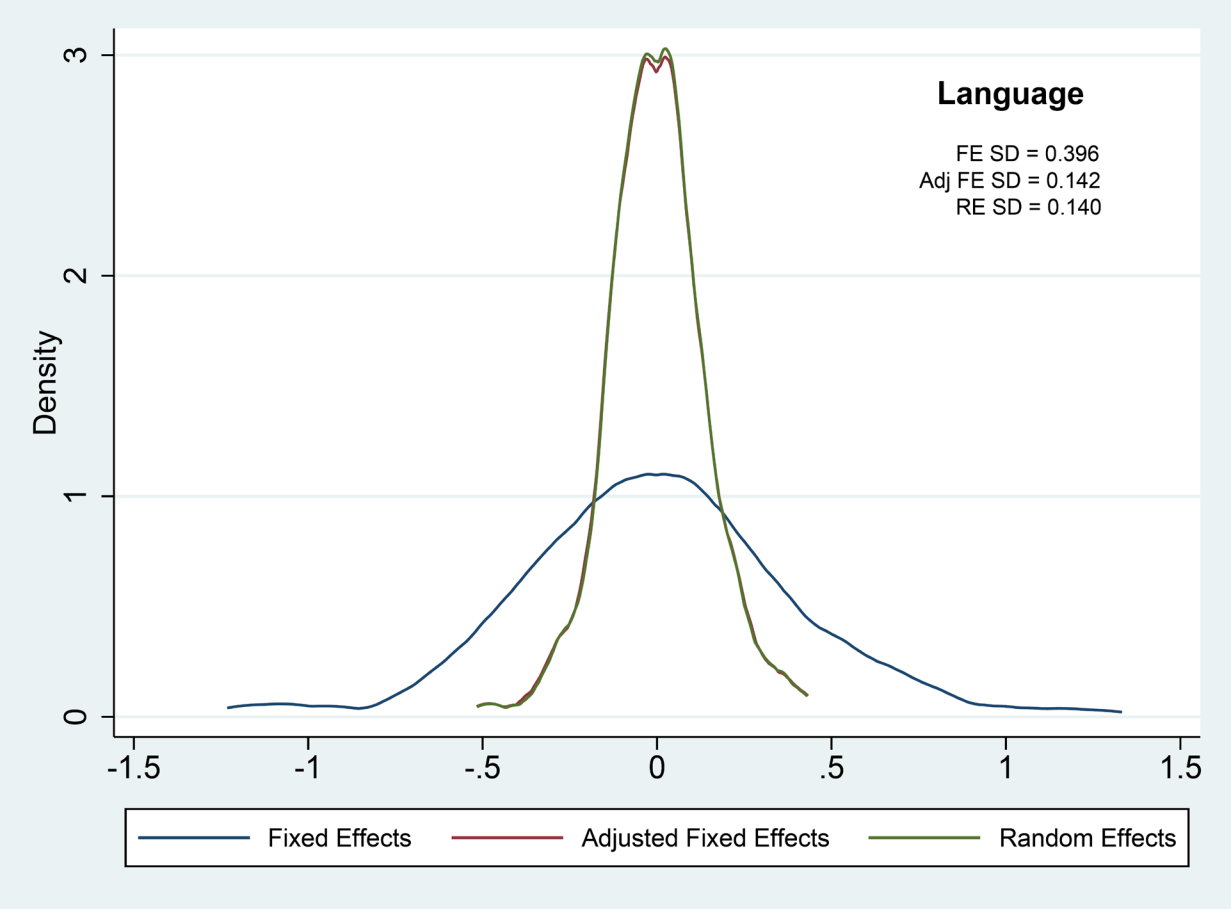
VI. Results: Classroom Effects on Math

	(1)	(2)	(3)	(4)	(5)
Classroom Fixed Effects (FE):					
Standard deviation	0.364	0.362	0.360	0.360	0.360
Adjusted EB standard deviation	0.119	0.121	0.120	0.120	0.120
p-value, F-test of classroom effects	0.000	0.000	0.000	0.000	0.000
Classroom Random Effects (RE):					
EB Standard deviation	0.122	0.124	0.124	0.124	0.124
p-value, F-test of classroom effects	0.000	0.000	0.000	0.000	0.000
Included covariates:					
Federal State effects	YES	YES	YES	YES	YES
Lagged test scores	YES	YES	YES	YES	YES
Student characteristics	NO	YES	YES	YES	YES
Parental background	NO	NO	YES	YES	YES
Classroom size	NO	NO	NO	YES	YES
Classroom averages	NO	NO	NO	NO	YES
Number of teachers/classrooms	251	251	251	251	251
Number of students threshold	5	5	5	5	5

Data: NEPS SUF, SC2 8.0.1, own calculations. Columns (2)-(5) control for the following student characteristics: age, gender, migration background; parental background: highest years of education, highest ISEI, number of siblings; classroom averages: proportion of females, average ISEI.

- **One s.d. increase in classroom quality is associated with at least 12% s.d. increase in student mathematical competence score.**

VI. Results: Classroom Effects on Language



VI. Results: Classroom Effects on Language

	(1)	(2)	(3)	(4)	(5)
Classroom Fixed Effects (FE):					
Standard deviation	0.403	0.398	0.397	0.397	0.396
Adjusted EB standard deviation	0.149	0.142	0.146	0.145	0.142
p-value, F-test of classroom effects	0.000	0.000	0.000	0.000	0.000
Classroom Random Effects (FE):					
EB Standard deviation	0.148	0.141	0.145	0.145	0.140
p-value, F-test of classroom effects	0.000	0.000	0.000	0.000	0.000
Included covariates:					
Federal State effects	YES	YES	YES	YES	YES
Lagged test scores	YES	YES	YES	YES	YES
Student characteristics	NO	YES	YES	YES	YES
Family background	NO	NO	YES	YES	YES
Classroom size	NO	NO	NO	YES	YES
Classroom averages	NO	NO	NO	NO	YES
Number of teachers/classrooms	240	240	240	240	240
Number of students threshold	5	5	5	5	5

Data: NEPS SUF, SC2 8.0.1, own calculations. *Notes:* Columns (2)-(5) control for the following student characteristics: age, gender, migration background; parental background: highest years of education, highest ISEI, number of siblings; classroom averages: proportion of females, average ISEI.

- **One s.d. increase in classroom quality is associated with at least 14% s.d. increase in student language competence score.**

VI. Results: Association to Teacher Characteristics

	Math		Language	
Teacher	EB Adjusted Fixed Effect (1)	EB Random Effect (2)	EB Adjusted Fixed Effect (3)	EB Random Effect (4)
Female	-0.067	-0.068	0.010	0.008
	(0.041)	(0.042)	(0.044)	(0.043)
Years of experience	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Abitur GPA	-0.012	-0.012	0.025*	0.025*
	(0.011)	(0.012)	(0.014)	(0.014)
FSE Grade	-0.001	-0.002	-0.030*	-0.030*
	(0.010)	(0.011)	(0.018)	(0.018)
SSE Passed	-0.006	-0.005	0.023	0.023
	(0.026)	(0.026)	(0.039)	(0.039)
Migration background	0.036	0.037	-0.022	-0.020
	(0.033)	(0.034)	(0.058)	(0.057)
Constructivist beliefs	0.010	0.010	0.017	0.017
	(0.012)	(0.013)	(0.011)	(0.011)
Exhaustion	-0.004	-0.005	-0.012	-0.012
	(0.009)	(0.010)	(0.013)	(0.013)
Parental evaluation	-0.001	-0.001	0.026**	0.025**
	(0.010)	(0.010)	(0.012)	(0.012)
Constant	0.044	0.043	-0.058	-0.055
	(0.050)	(0.051)	(0.061)	(0.061)
Number of teacher with observables	147	147	141	141
R^2	0.049	0.049	0.102	0.102

*Data: NEPS SUF, SC2 8.0.1, own calculations. Notes: Standard errors in parentheses. * Significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level.*

VI. Results: Parental Behavioral Responses

	Time Helping with Homework (h)		Private Tutoring		Private Tutoring (German)	
	(1)	(2)	(3)	(4)	(5)	(6)
Teacher meets child's needs:						
Does rather apply	-0.369	-0.181	-0.083**	-0.076**	-0.064**	-0.061**
	(0.308)	(0.294)	(0.036)	(0.035)	(0.031)	(0.031)
Does apply	-0.221	-0.086	-0.089**	-0.082**	-0.073*	-0.071**
	(0.299)	(0.283)	(0.035)	(0.035)	(0.031)	(0.031)
Included covariates:						
Federal State effects	YES	YES	YES	YES	YES	YES
Lagged test scores	NO	YES	NO	YES	NO	YES
Student characteristics	NO	YES	NO	YES	NO	YES
Family background	NO	YES	NO	YES	NO	YES
Classroom size	NO	YES	NO	YES	NO	YES
Classroom averages	NO	YES	NO	YES	NO	YES
N	1652	1652	1752	1752	1752	1752
R^2	0.015	0.049	0.026	0.052	0.037	0.049

*Data: NEPS SUF, SC2 8.0.1, own calculations. Columns (2), (4) and (6) control for the following student characteristics: lagged math, language and science competence, age, gender, migration background; parental background: highest years of education, highest ISEI, number of siblings; classroom averages: proportion of females, average ISEI. Standard errors (in parentheses) clustered at the individual level. Total number of observations corresponds to valid parental answers to the dependent variables in the language student sample. * Significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level.*

VI. Results: Classroom Effects on later-life outcomes (tracking at g4 and g5)

Math Classroom	(1) Academic track Actual g5	(2) Academic track Actual g5 (reduced form)	(3) Academic track Recommendation g4	(4) Academic track Recommendation g4 (reduced form)
EB Adjusted Fixed Effect	0.291**	0.280**	0.235*	0.224**
	(0.146)	(0.135)	(0.122)	(0.114)
EB Random Effect	0.285**	0.274**	0.231**	0.220**
	(0.130)	(0.128)	(0.115)	(0.111)
Included covariates:				
Federal State effects	YES	YES	YES	YES
Test scores	YES	YES	YES	YES
Student characteristics	YES	YES	YES	YES
Family background	YES	YES	YES	YES
Classroom size	YES	YES	YES	YES
Classroom averages	YES	YES	YES	YES
N	729	729	1024	1024
R^2	0.288	0.006	0.333	0.004

*Note: Data: NEPS SUF, SC2 8.0.1, own calculations. Columns (2), (4) and (6) control for the following student characteristics: math, language competence, age, gender, migration background; parental background: highest years of education, highest ISEI, number of siblings; classroom averages: proportion of females, average ISEI. Bootstrap standard errors (parentheses) * p < 0.1, ** p < 0.05, *** p < 0.01*

VII. Conclusion

- **Substantial teacher-classroom effects on competence development** (quality differences) in the German primary school**.**
- **One s.d increase in classroom quality is associated with at least 12% s.d. increase in student mathematical competence score, and at least 14% s.d. increase in language competence score.**
- Easily quantifiable teacher characteristics (used in teacher recruitment processes) explain very little of the variance of the classroom effects.
- **Parental evaluation of teacher quality** is the only covariate that is significantly and positively associated to classroom effects on language competence development.
- Possible association of classroom value-added in primary school with later outcomes (tracking)