Improving the quality of education in developing countries

An experimental evaluation of teacher training programs in El Salvador

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Seminar on "Analytical Sociology: Theory and Empirical Applications",
Venice International University, November 18-21, 2024

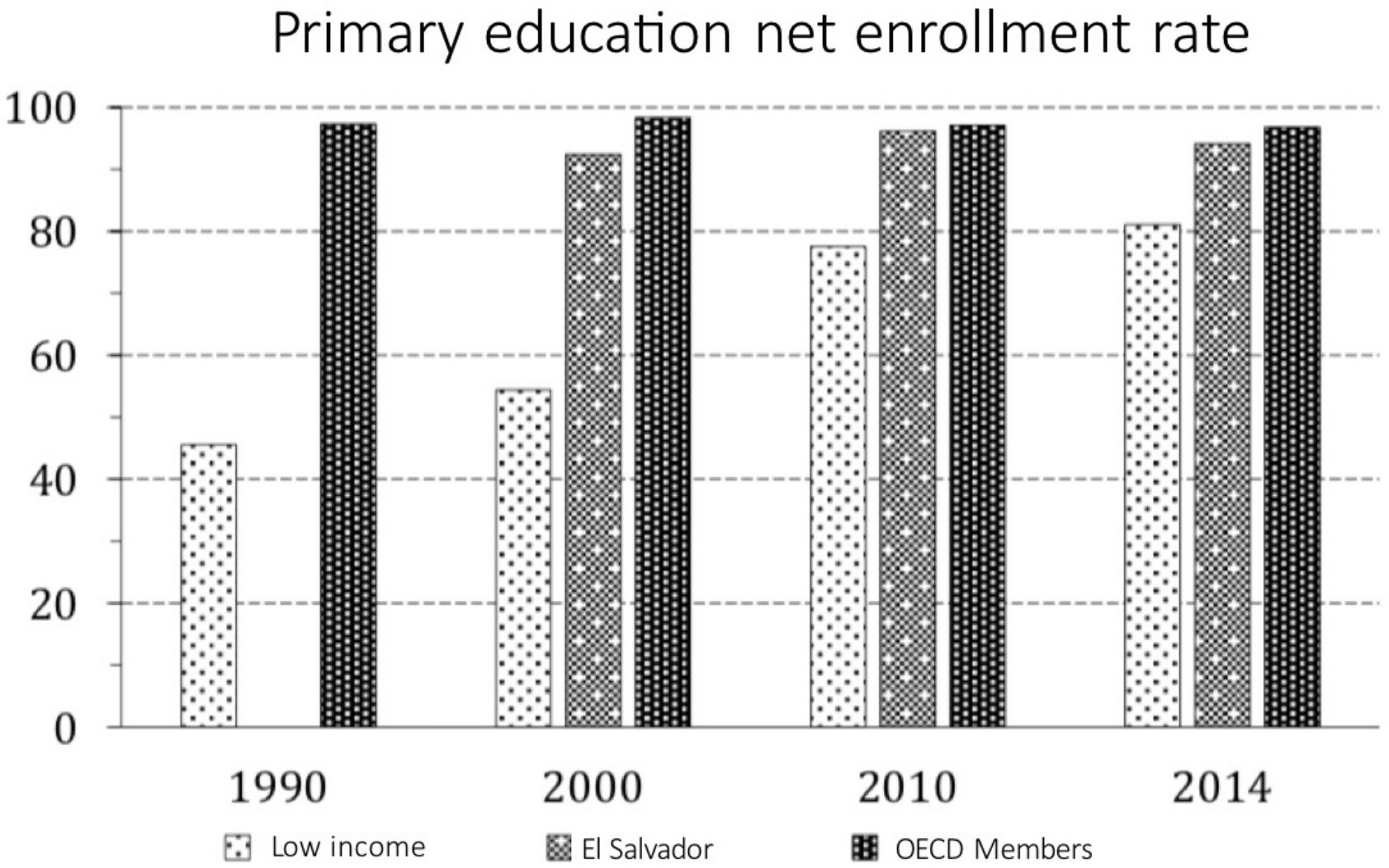
Outline

Quiz

What do you think, how many primary-school-age children are enrolled in school in low-income countries?

- ☐ **20% or less**
- ☐ **between 20% and 40%**
- ☐ **between 40% and 60%**
- ☐ **between 60% and 80%**
- ☐ **80% or more**

Quiz



Data source: World Bank

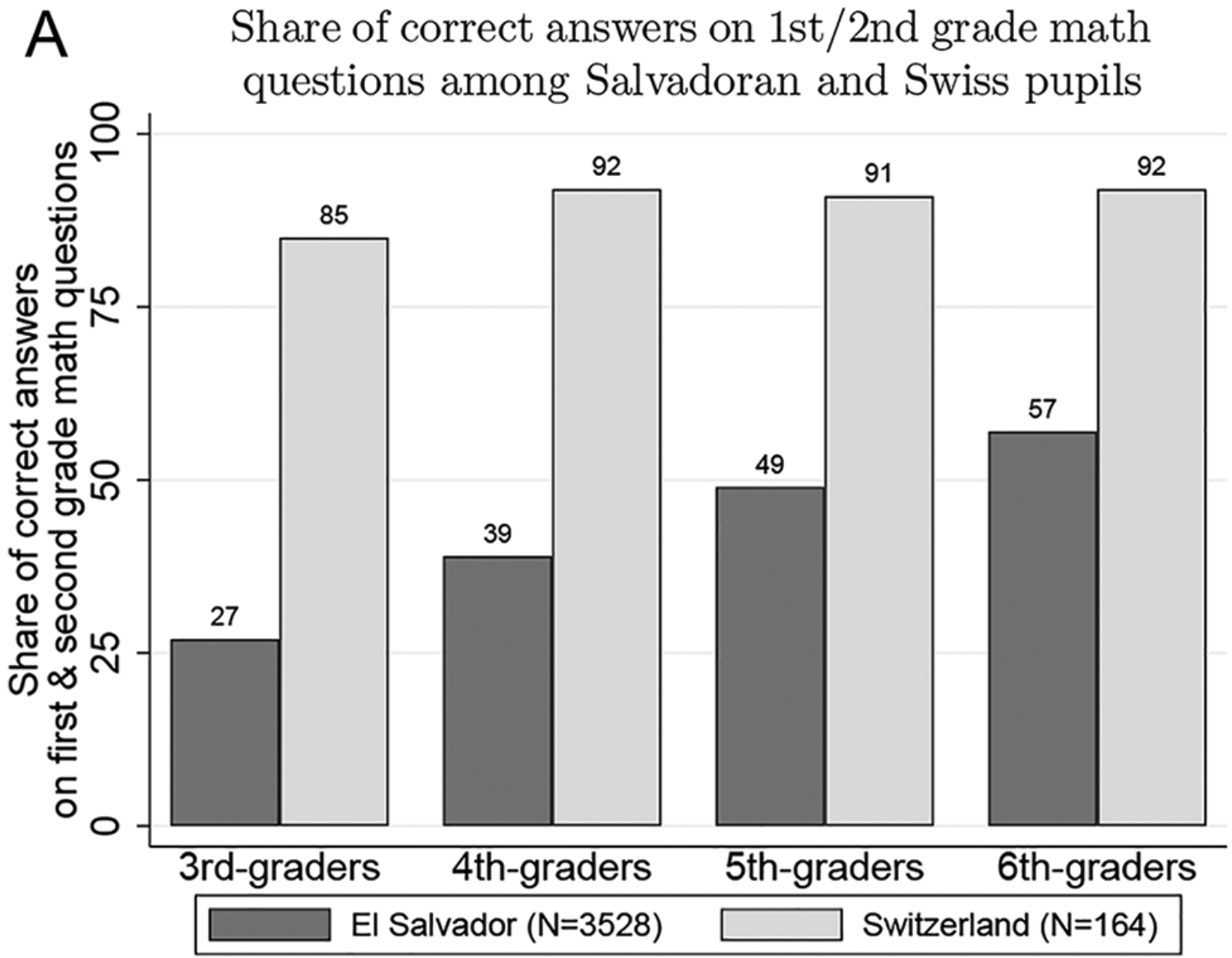
The problem

- Improved school enrollment rates in developing countries . . .
- . . . but very poor learning outcomes
- "Schooling is not Learning"

World Bank

There is a "Learning Crisis".

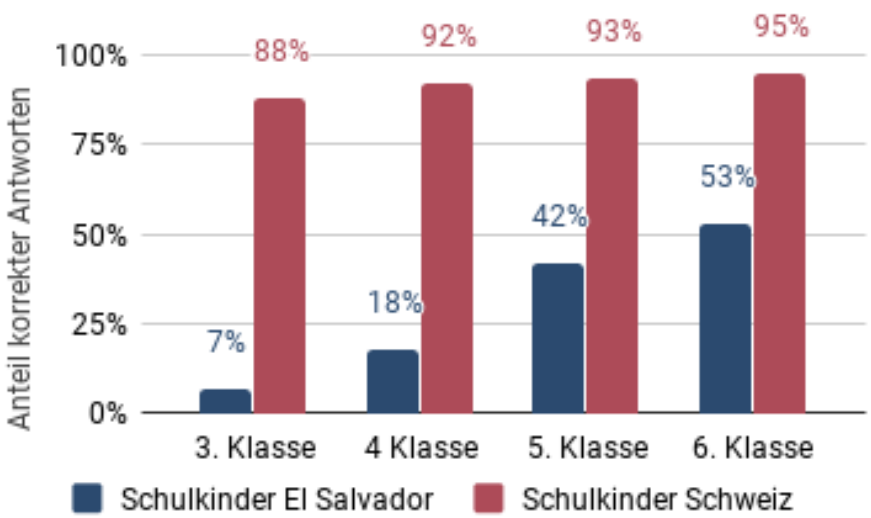
The problem



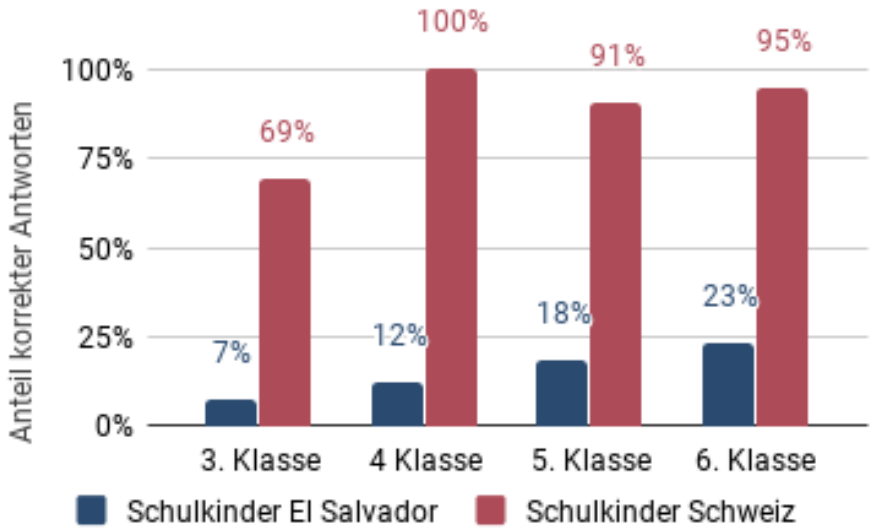
(Büchel et al. 2022)

The problem

What's 8 : 2?



What time is it?



What to do?

- Various suggestions can be found in the literature why learning success is so low even though enrollment rates are hight.
  - Absenteeism by students and teachers.
  - Lack of resources and learning materials.
  - Large classes.
  - ...
- One idea to improve the situation is to provide additional teaching using computer-assisted learning (CAL) tools.
  - In 2018, together with NGO Consciente, University of Bern ran a randomized controlled trial (RCT) in El Salvador to evaluate the impact of such an intervention.
  - The intervention focused on mathematics.
  - For full details of the study, see Büchel et al. (2022).


Mexico
Belize
Honduras
Guatamala
El Salvador
Nicaragua
Costa Rica
Panama


Morazan
Cuilapa
Jutiapia
Metapan
La Esperanza
Comayagua
La Paz
Chalatenango
Chalchuapa
Santa Ana
Ahuachapan
Coatepeque
Aguilares
San Juan Opico
Sensuntepeque
Armenia
Sonsonate
Nueva San Salvador
SAN SALVADOR
Cojutepeque
San Vicente
Ciudad Barrios
San Francisco
Santa Rosa de Lima
Acajutla
Panchimalco
Berlin
Santiago Nonualco
Zacatecoluca
San Miguel
San Alejo
La Unión
Usulután
1 AHUACHÁPAN
2 SANTA ANA
3 CHALATENANGO
4 CABAÑAS
5 SAN MIGUEL
6 MORAZÁN
7 LA UNIÓN
8 USULUTÁN
9 SAN VICENTE
10 LA PAZ
11 CUSCATLÁN
12 SAN SALVADOR
13 LA LIBERTAD
14 SONSONATE
EL SALVADOR
0 km 20 40 60 km
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PACIFIC OCEAN
Golfo de Fonseca

Interventions (additional math lessons)

2 x 90 min./week

40 classes, ≈ 800 children

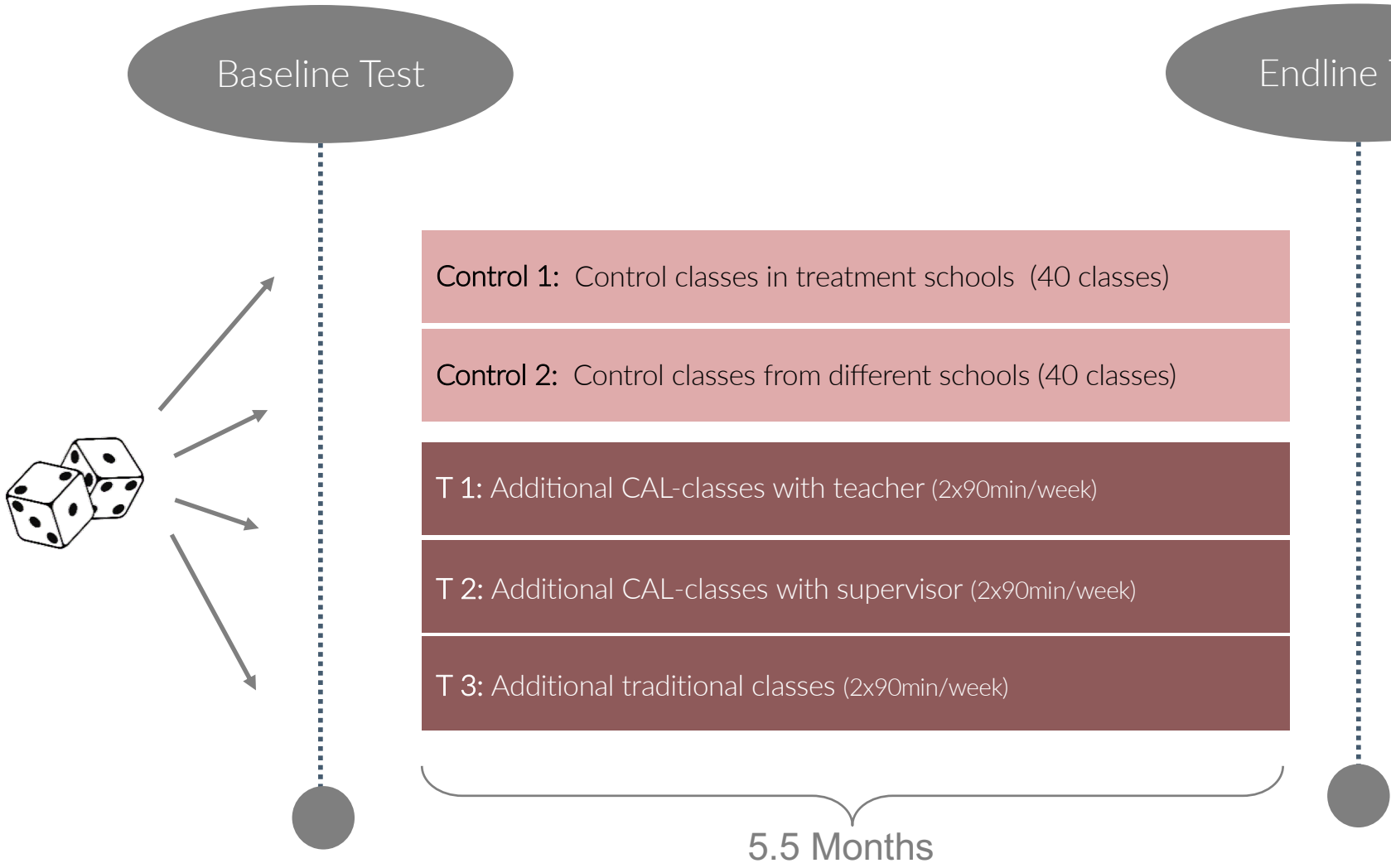
2 x 90 min./week

39 classes, ≈ 800 children

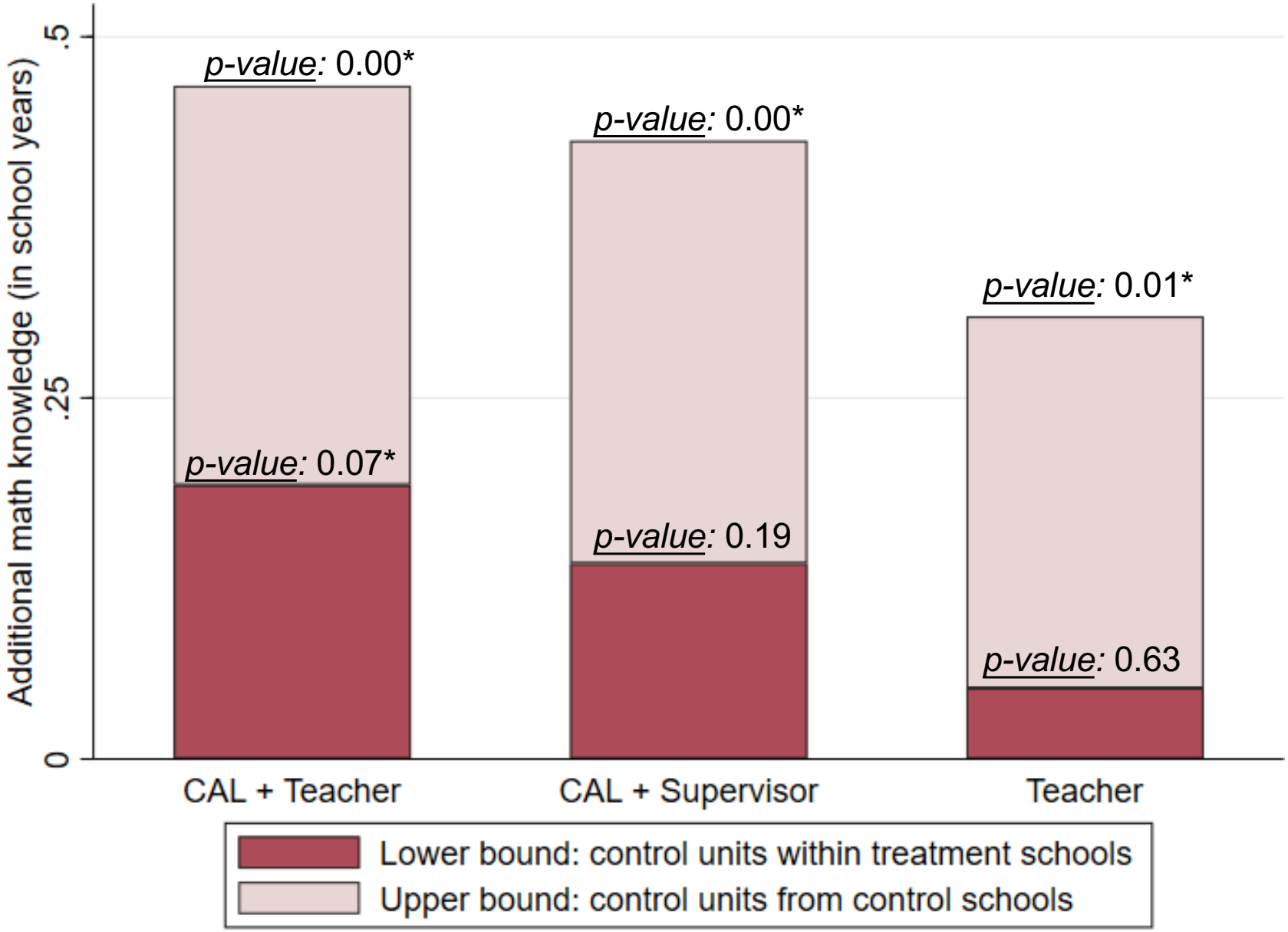
2 x 90 min./week

30 classes, ≈ 800 children

Experimental design



Main results

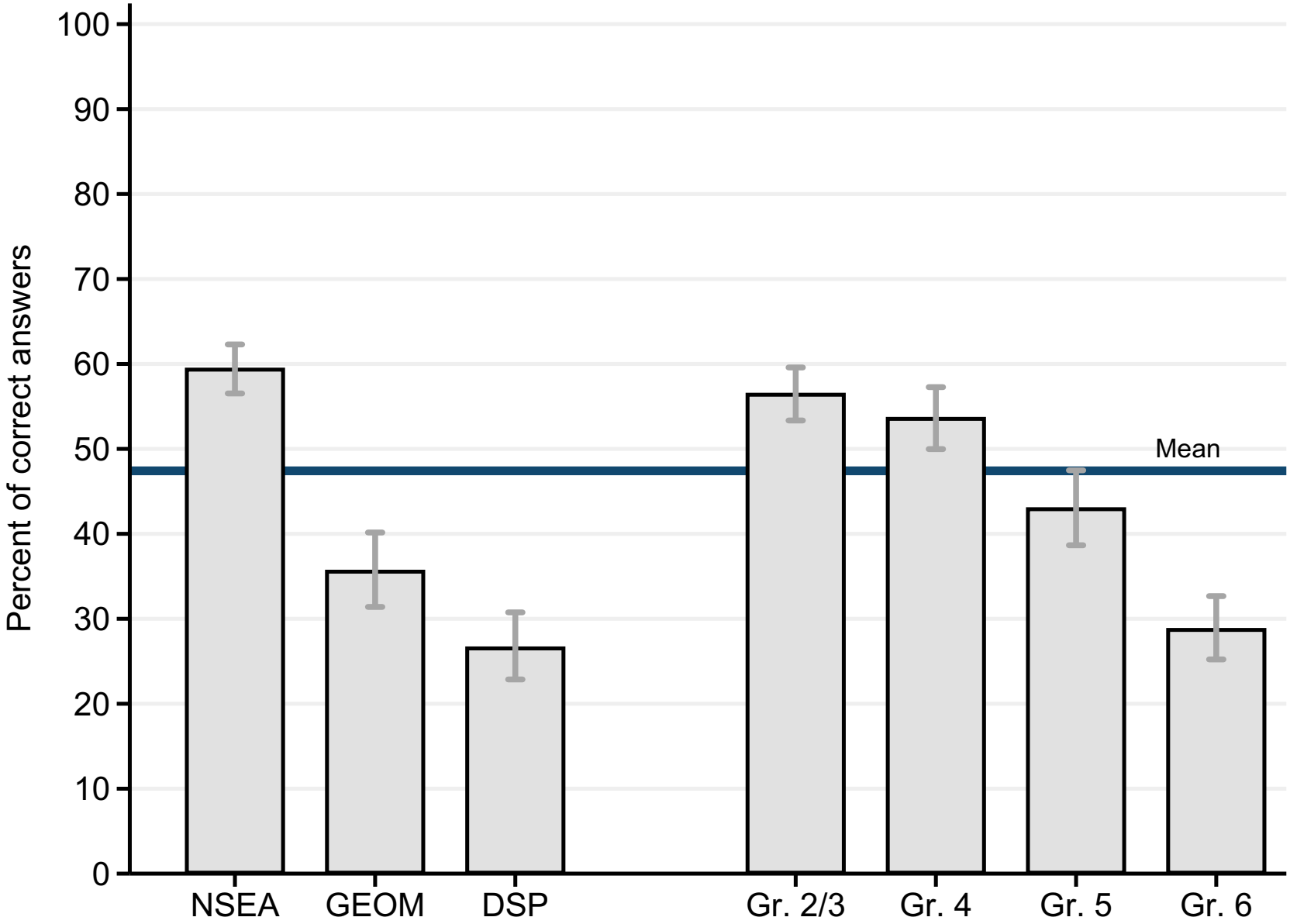


Lessons learned

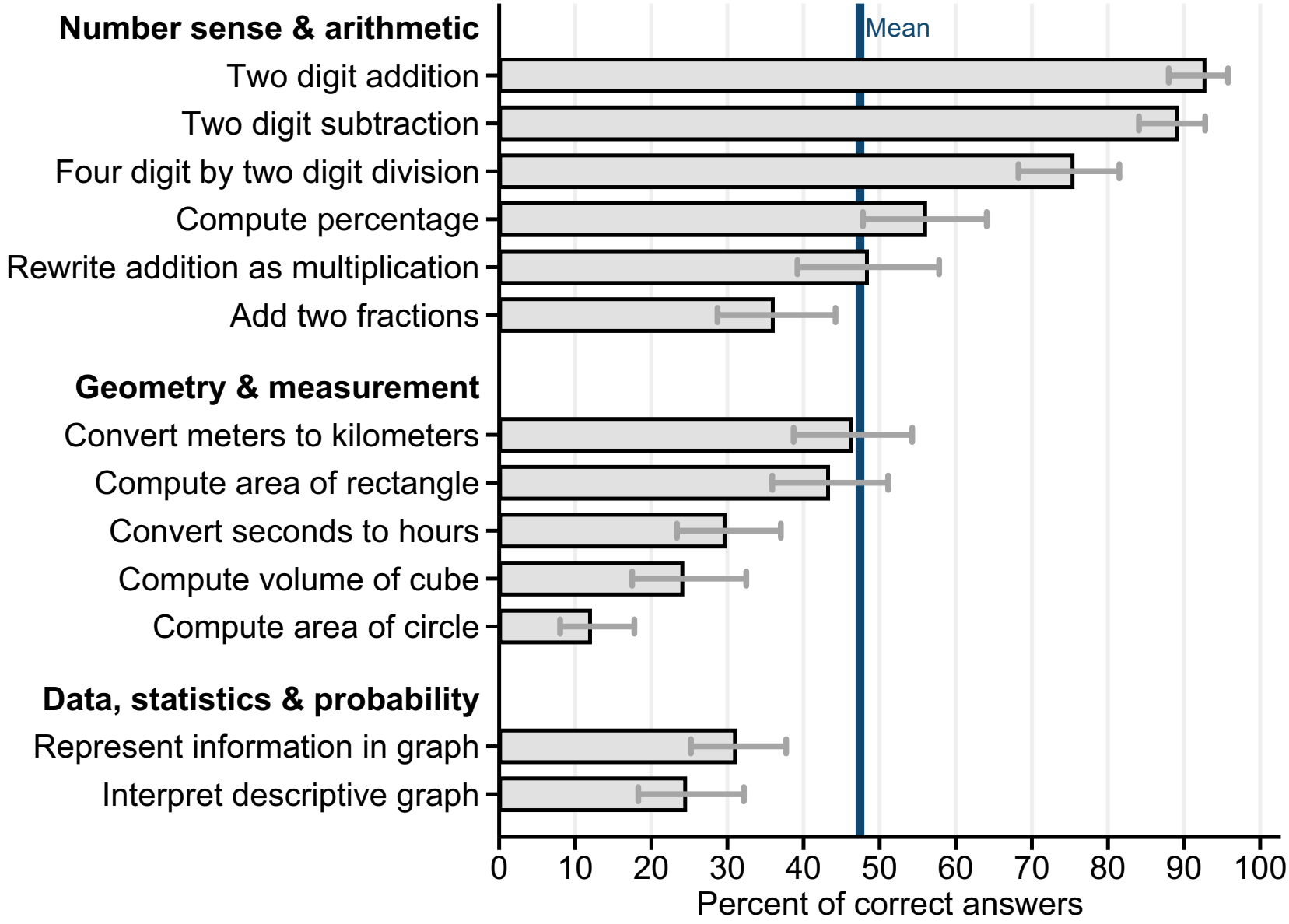
- The additional teaching led to considerable learning gains in math.
- CAL instructed by teachers had the largest impact.
- (Weak) evidence that CAL is more effective than additional lessons taught by teachers.
- There were strong spillover effects within schools.

- As a byproduct of the project, we noticed that regular teachers' knowledge of the content they were supposed to teach was really poor.
  - To confirm this impression, we ran a second study systematically testing teachers (Brunetti et al 2020).
  - Random sample of 224 primary-school math teachers in El Salvador (Department of Morazan).
  - Math test covering topics taught in 2nd to 6th grade.

Main results



Main results



And it matters!

Table A.8: Relation between teacher's test score and students' learning over an eight month evaluation period and in a sample of Salvadorian primary school classes of grades 3 to 6.

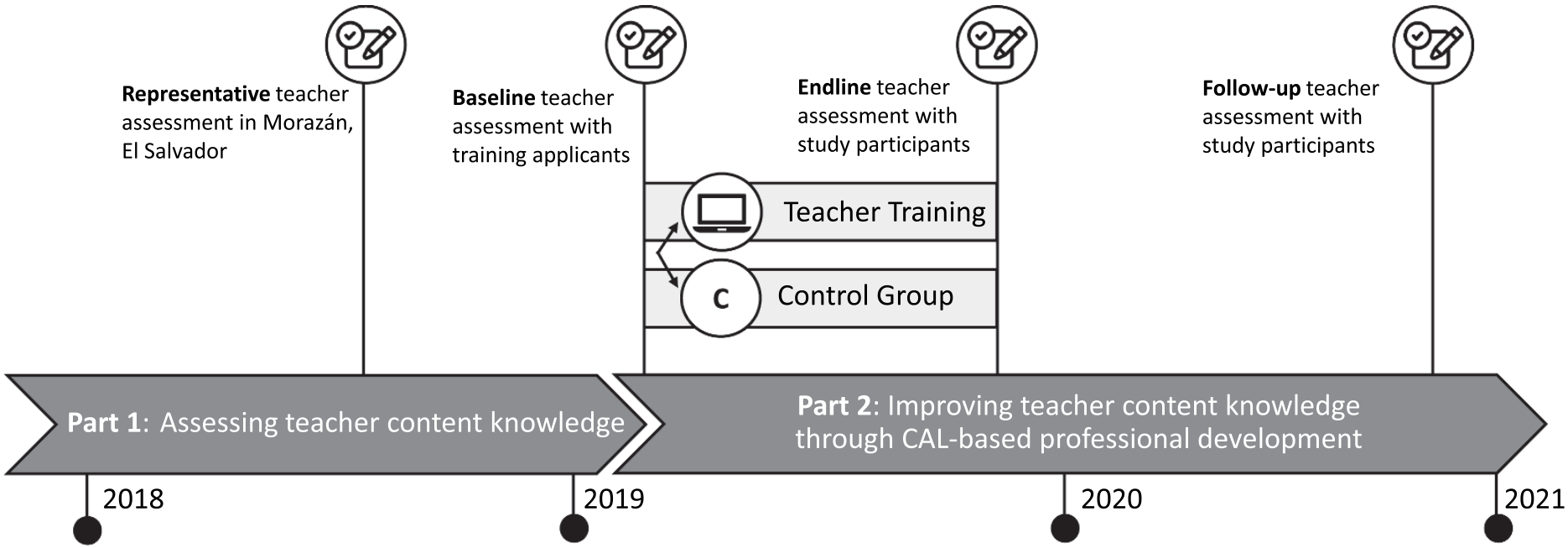
	Student learning gains							
	Standardized (σ)				School year equivalents			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Standarized teacher score	0.098***	0.091***	0.097***	0.116***	0.276***	0.256***	0.274***	0.324***
	(0.031)	(0.032)	(0.031)	(0.036)	(0.083)	(0.085)	(0.080)	(0.091)
Grade level fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Class level controls	No	Yes	Yes	Yes	No	Yes	Yes	Yes
School level controls	No	No	Yes	Yes	No	No	Yes	Yes
Teacher controls	No	No	No	Yes	No	No	No	Yes

Notes: As the student data was collected for an experimental evaluation of a computer-assisted learning intervention, all models control for the treatment assignment of classes. Number of observations: 2786 students, 120 teachers, 48 schools. School-level clustered standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Teacher training pilot study 2019–2021

- The results of the teacher content knowledge study indicate that one major reason for the "Learning Crisis" is poorly trained teachers.
- We thus launched an RCT to evaluate the impact of a computer-assisted teacher training program (Brunetti et al. 2024).
  - In-service teacher training program with primary school math teachers in Morazan, El Salvador, ...
    - ★ to improve teacher content knowledge in math
    - ★ to improve their teaching,
    - ★ and, hopefully, to improve student math skills
  - Treatment (incentivized)
    - ★ 16 self-study modules covering selected contents of the Salvadoran primary school math curriculum; participants received a laptop equipped with the learning software and had to complete one module per week, corresponding to a workload of four to eight hours
    - ★ monthly in-person workshops where participants' learning progress was evaluated and expert teachers recapitulated key concepts and addressed teachers' questions
  - 87 teachers in the treatment group, 88 teachers control group

Timeline


Representative teacher assessment in Morazán, El Salvador
Baseline teacher assessment with training applicants
Endline teacher assessment with study participants
Follow-up teacher assessment with study participants
Teacher Training
C
Control Group
Part 1: Assessing teacher content knowledge
Part 2: Improving teacher content knowledge through CAL-based professional development
2018
2019
2020
2021

David, participant of the teacher training

"I have been teaching mathematics since 2012 and I often had problems conveying the materials. In Consciente's teacher training, I began to learn each exercise, lesson and module in an appropriate way and with good didactics – from the comfort of my home with my laptop. It was not easy, but the satisfaction I felt at the end of each of the activities always motivated me. When I came home from school, my wife already knew that I would have little time for her and would spend the evening in front of the computer. But she understood that my learning was important because my students deserve a good education. ¡Mil gracias, Fundación Consciente!"

Main results

Table 1: ITT-estimates for the program effects on teachers' math scores

	Immediate effect				Effect after one year			
Dependent variable:	Percent correct		Standardized		Percent correct		Standardized	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	5.38***	5.52***	0.28***	0.29***	0.61	1.48	0.03	0.08
	(1.46)	(1.49)	(0.08)	(0.08)	(1.78)	(1.77)	(0.10)	(0.10)
Baseline score	0.90***	0.85***	0.92***	0.86***	0.77***	0.64***	0.82***	0.68**
	(0.09)	(0.10)	(0.09)	(0.10)	(0.12)	(0.13)	(0.13)	(0.14)
Adjusted R^2	0.80	0.81	0.80	0.81	0.69	0.71	0.69	0.71
Observations	164	164	164	164	136	136	136	136
Teacher controls[a]	No	Yes	No	Yes	No	Yes	No	Yes
School controls[b]	No	Yes	No	Yes	No	Yes	No	Yes
Stratum FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The *immediate effect* is estimated based on the endline data collected in September 2019 about one month after the intervention concluded. The persistency of the *effect after one year* is estimated based on the follow-up data collected in September 2020. In *columns (3), (4), (7), and (8)*, the share of correct answers is standardized to have a wave-specific mean of zero and a wave-specific standard deviation of one in the control group. *a: Teacher level controls* include age, educational degree, years since graduation, commuting time to school as well as binary indicators for gender and math specialization. *b: School level controls* are an infrastructure index, an equipment index, travel time to the department's capital as well as binary indicators for the availability of a computer lab, exposure to gang activities, and location in a rural area. Huber-White robust standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01.

Conclusions from the pilot study

- Immediately after the intervention, the program had a significantly positive effect. Treated teachers clearly outperformed their peers from the control group.
  - Effects on students could not be measured due to school closures related to the Covid-19 pandemic.
- Heterogeneous immediate effects among several dimensions. For example, older teachers were significantly less perceptive than their younger colleagues.
- However, one year after the program, all effects largely disappeared!
  - This questions the desired multiplier impact of a teacher-centered intervention (i.e., that a one-time intervention among teachers leads to learning gains among many cohorts of students).
- Yet, because teachers are so fundamental, we decided to launch a full-scale study on the effectiveness of teacher training interventions.

Our study

- Project funded by the Swiss National Science foundation, running 2021–2024.
- Cooperation between the Department of Economics and the Institute of Sociology, University of Bern, and NGO Consciente.
- For the design and implementation of interventions we initially cooperated with experts from an University of Teacher Education; after some time we hired a pedagogy specialist directly on the project.
- The goal was to develop and evaluate dedicated teacher-training programs targeting content knowledge as well as pedagogy in mathematics.
  - Intense training programs.
  - Systematic testing of teachers and students at several time points to measure learning success.
  - Classroom observations to measure the impact on teaching practice.

Motivation

- Teachers are key to quality education.
  - They are the most important input to the educational production function. (Baumert & Kunter 2013, Hanushek 2011)
  - There is a robust link between teacher quality and students' test scores in low- and middle-income countries. (Araujo et al. 2016, Bau & Das 2020, Buhl-Wiggers et al. 2018)
  - Teacher content knowledge is associated positively with student learning. (Metzler & Woessmann 2012, Bau & Das 2020, Bold et al. 2019, Bietenbeck et al. 2018)
  - There is positive link between improved pedagogy and learning outcomes. (e.g. Glewwe & Muralidharan 2016, Conn 2017)
- The situation in El Salvador:
  - Poor content knowledge of teachers (as seen above).
  - Poor pedagogical practices and/or motivation of teachers, "chalk and talk" lecturing style, overly demanding curriculum.

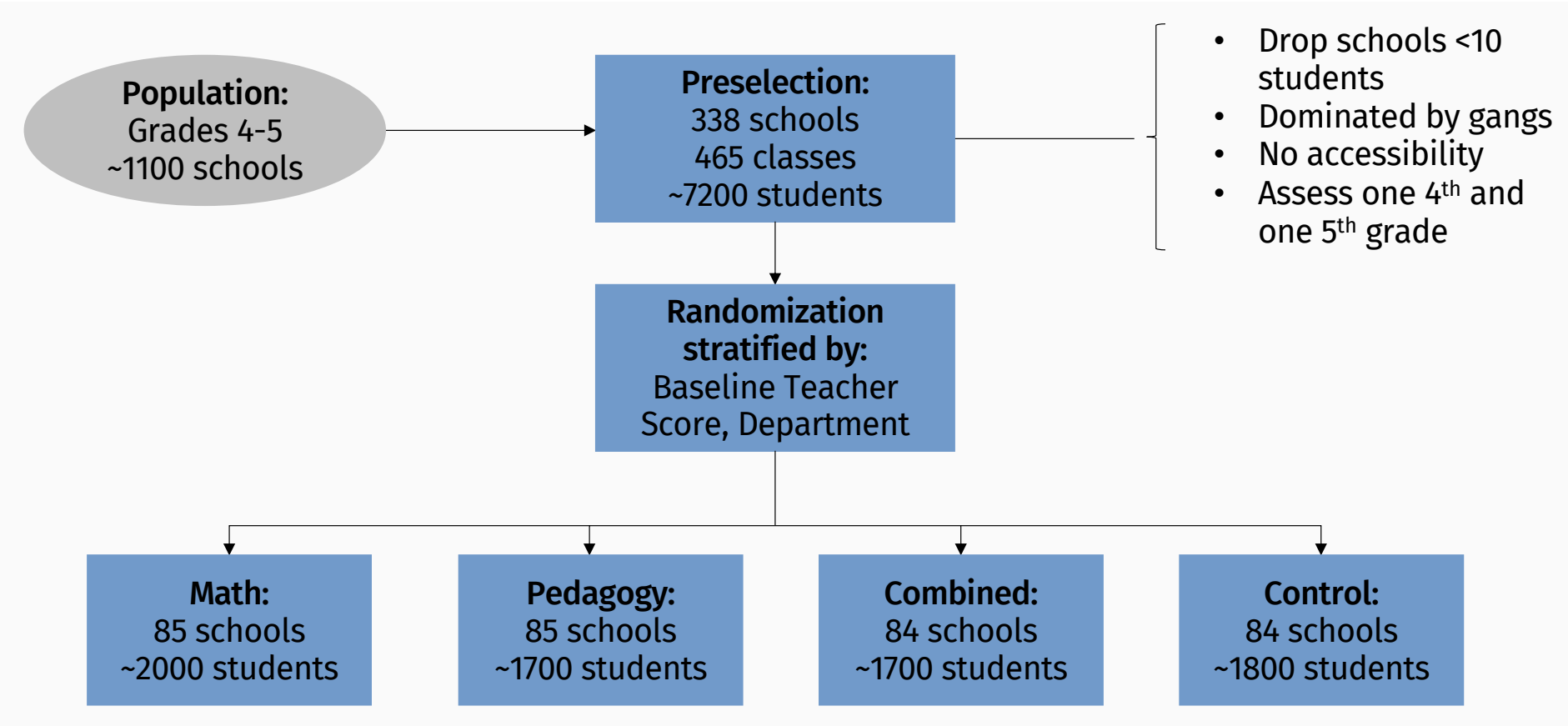
Interventions

- Six months teacher training focusing on . . .
  1. content knowledge in mathematics at primary-school level,
  2. general pedagogical practices (no specific focus on math), and . . .
  3. a combination of 1. and 2.

Math Focus: Teaching mathematic content competencies.	**General pedagogy** Focus: Teaching didactic competencies	**Pedagogy and Math** Focus: Combination of DG and MA elements to enable teaching of didactic and mathematical competencies.
On-site workshops	On-site workshops	On-site workshops
Audiovisual material	Audiovisual material	Audiovisual material
Self-study	Self-study	Self-study
Coaching	Coaching	Coaching

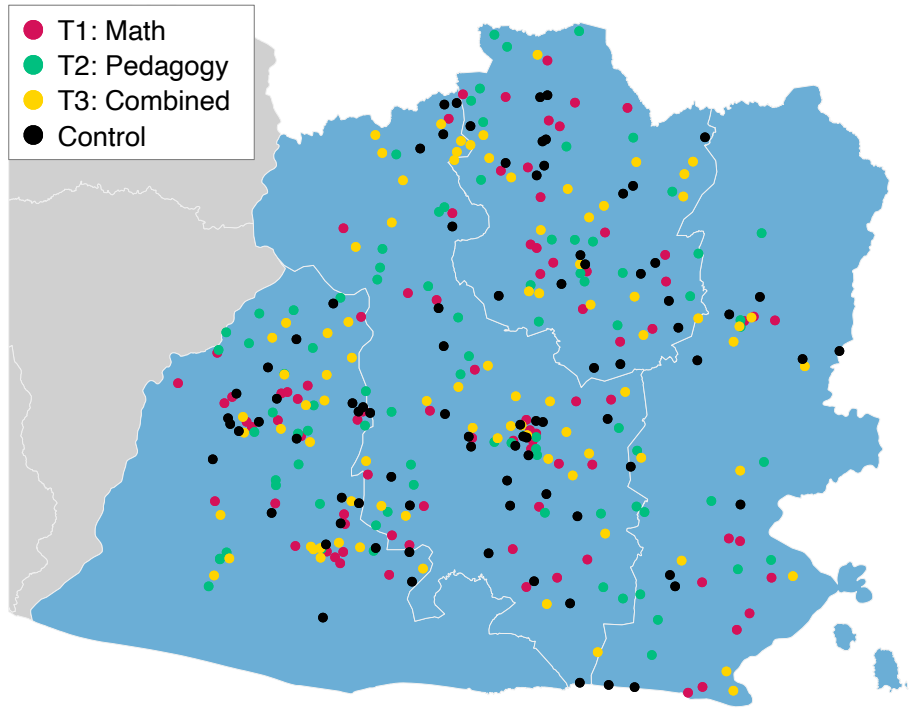
- The training material have been published at mdid.consciente.ong.

Experimental design



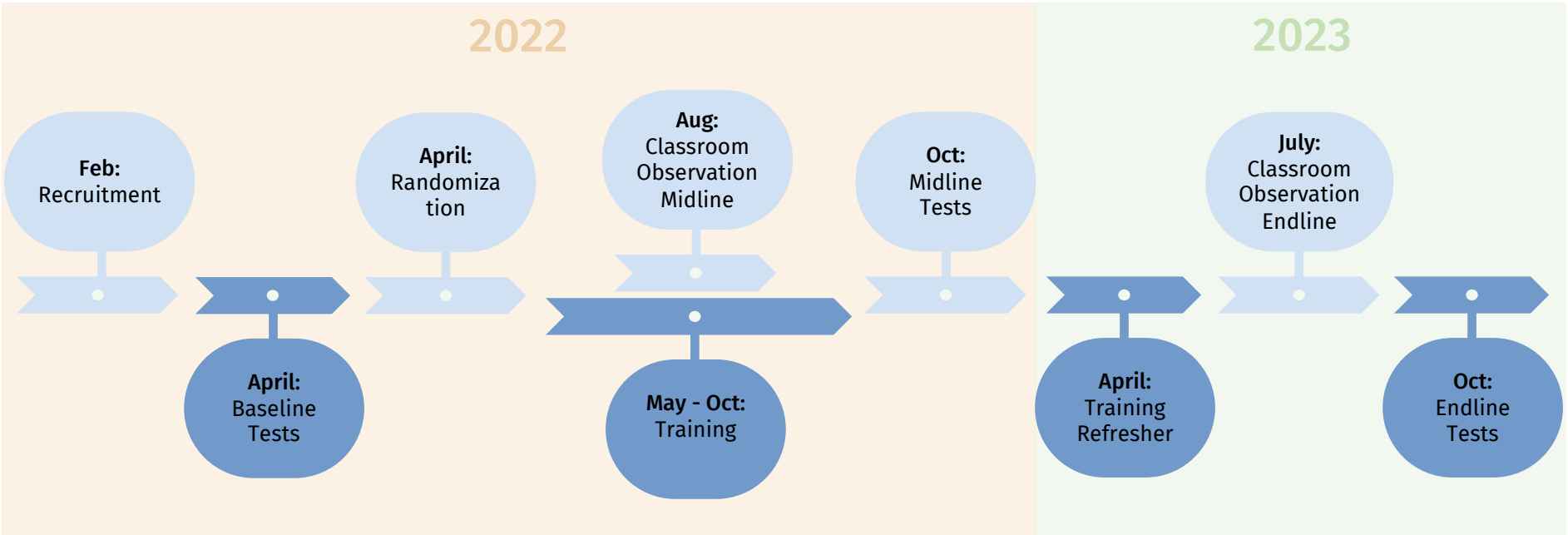
Sample and randomization

Departments in sample



Schools in sample

Timeline


2022
2023
Feb:
Recruitment
April:
Baseline
Tests
April:
Randomiza
tion
Aug:
Classroom
Observation
Midline
May - Oct:
Training
Oct:
Midline
Tests
April:
Training
Refresher
July:
Classroom
Observation
Endline
Oct:
Endline
Tests

Balancing at baseline: teachers

	Control	T1	T2	T3	p	p^{fe}	N
Math variables							
Baseline test score	0.59	0.61	0.63	0.61	0.650	0.037	338
Favorite subject is math	0.71	0.68	0.60	0.69	0.463	0.266	314
Least favorite subject math	0.11	0.09	0.11	0.12	0.958	0.921	236
Teaches math exclusively	0.90	0.96	0.95	0.94	0.451	0.409	338
Class variables							
Number of classes	1.46	1.48	1.32	1.33	0.054	0.046	333
Average class size	15.46	17.54	15.53	15.96	0.406	0.394	333
Teaches both 4th and 5th grade	0.46	0.48	0.32	0.33	0.054	0.046	333
Teaches only 4th grade	0.29	0.24	0.31	0.29	0.778	0.744	333
Teaches only 5th grade	0.25	0.28	0.37	0.39	0.169	0.191	333
Sociodemographic variables							
Female	0.64	0.62	0.59	0.64	0.872	0.863	338
Age in years	45.60	47.90	46.86	46.14	0.521	0.423	336
Years of teaching experience	10.26	11.19	13.63	11.30	0.152	0.141	330
Has a bachelor degree	0.40	0.35	0.46	0.46	0.405	0.369	338

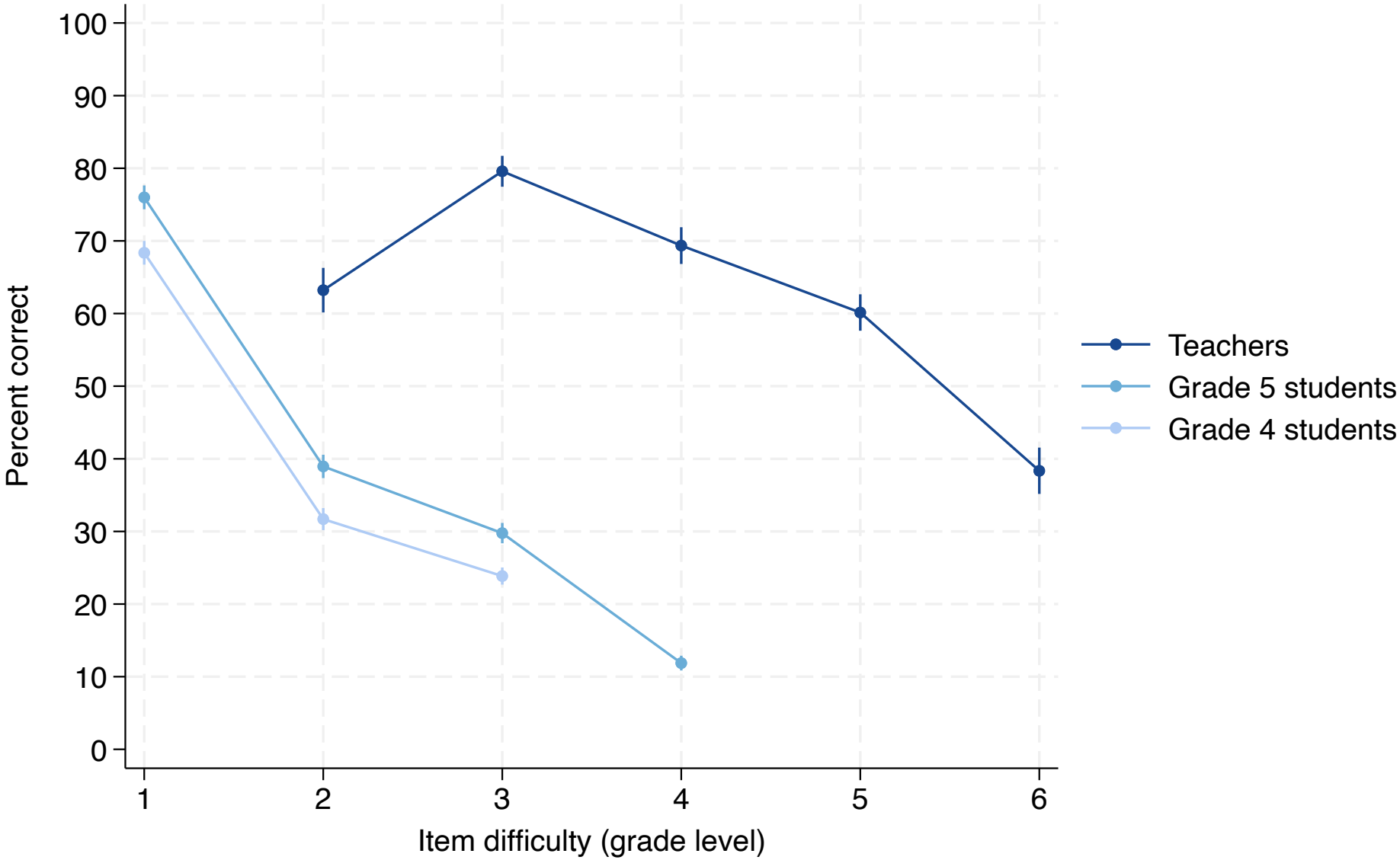
p^{fe}: p-value from model including strata fixed-effects

Balancing at baseline: students

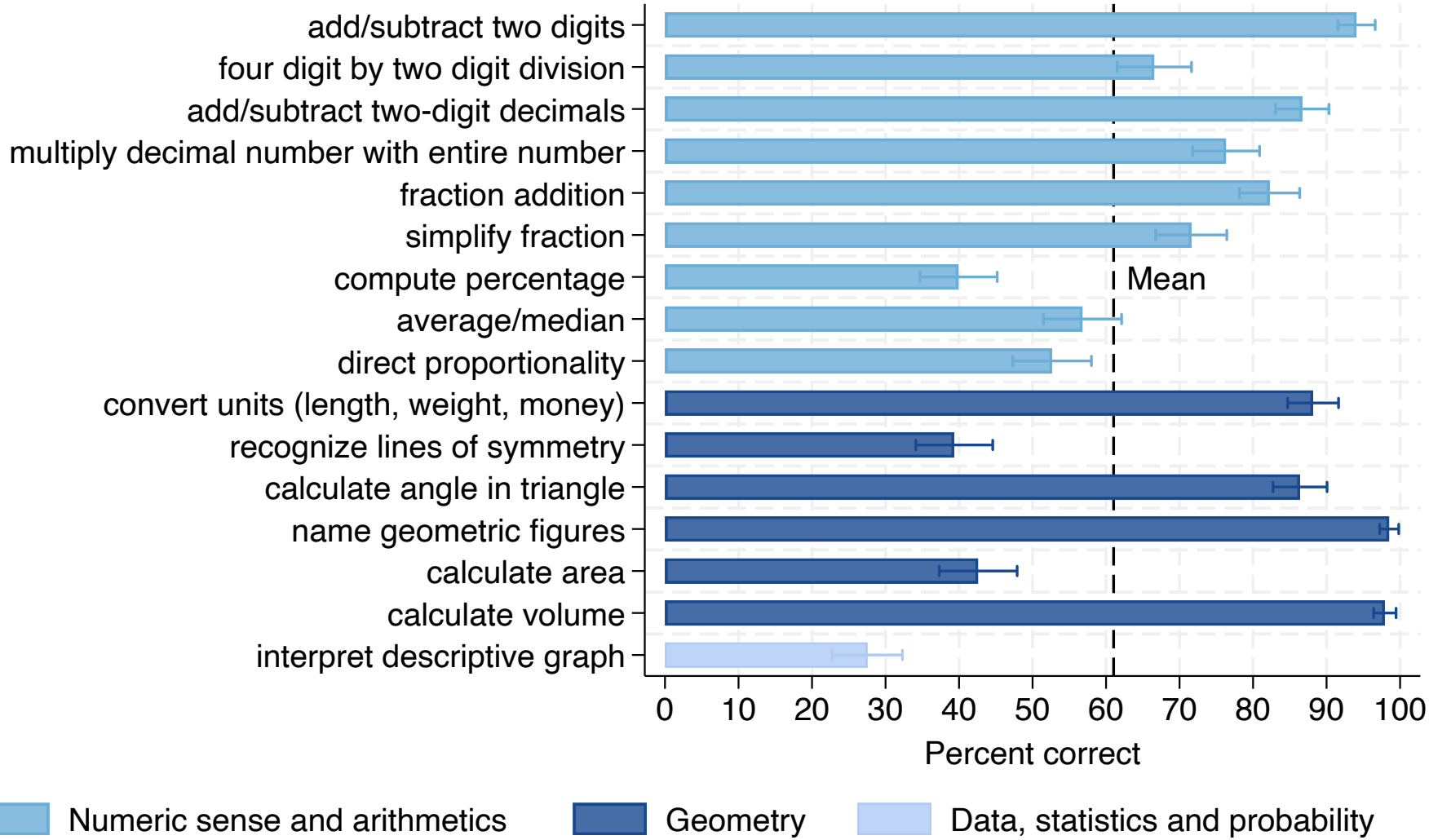
	Control	T1	T2	T3	p	p^{fe}	N
Math variables							
Baseline test score	0.29	0.29	0.28	0.30	0.015	0.298	6010
Favorite subject is math	0.43	0.41	0.42	0.42	0.615	0.876	5399
Least favorite subject math	0.41	0.40	0.38	0.37	0.202	0.608	5038
Sociodemographic variables							
Female	0.49	0.50	0.51	0.48	0.325	0.253	5865
Age in years	10.66	10.73	10.75	10.71	0.147	0.662	5556
Household has electricity	0.98	0.99	0.98	0.98	0.092	0.224	6073
Household has a fridge	0.90	0.90	0.91	0.90	0.538	0.894	6002
Household has a car	0.41	0.43	0.42	0.42	0.835	0.878	5707
Number of household members	5.31	5.34	5.26	5.25	0.594	0.720	5879

p^{fe}: p-value from model including strata fixed-effects

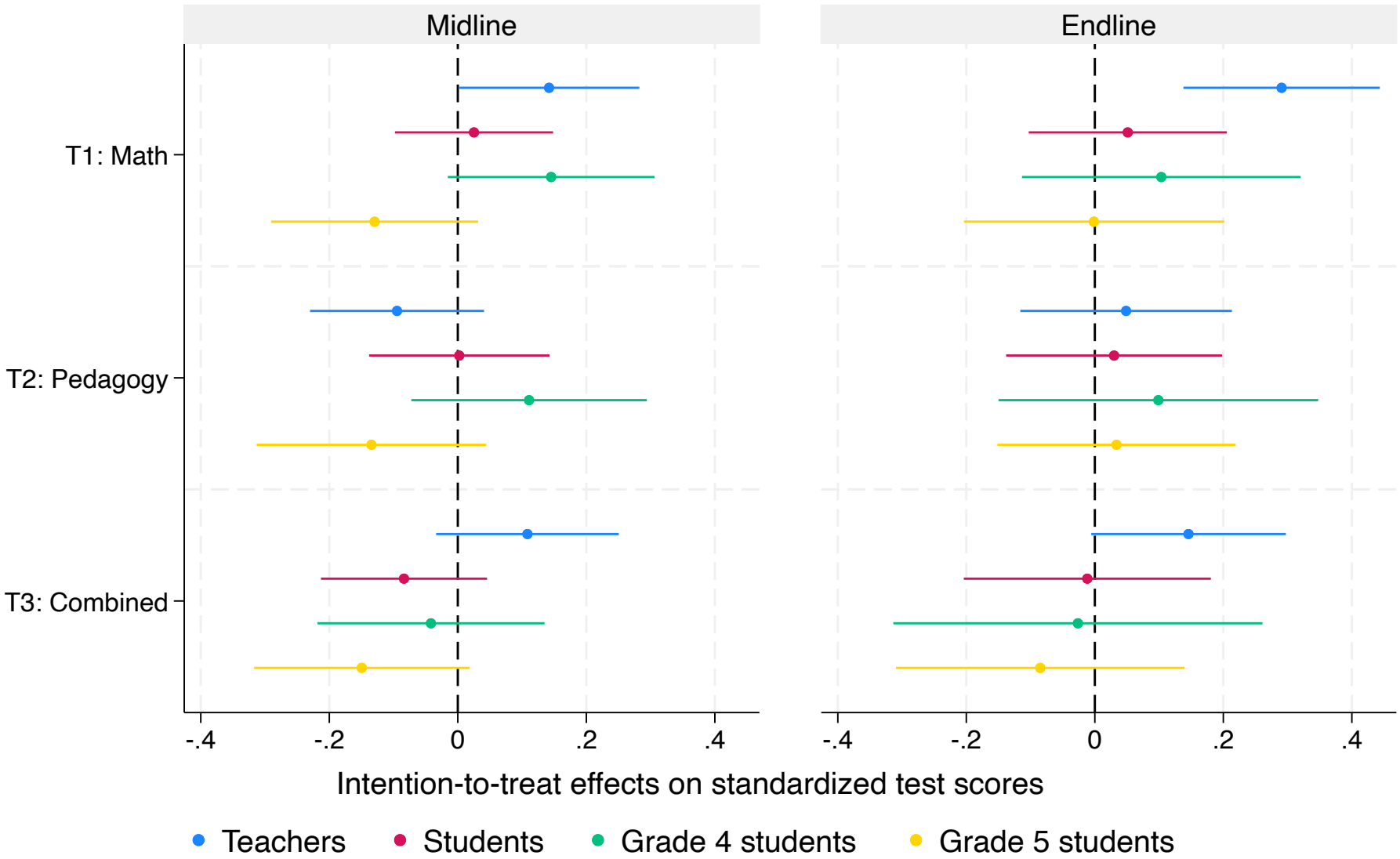
Test performance at baseline



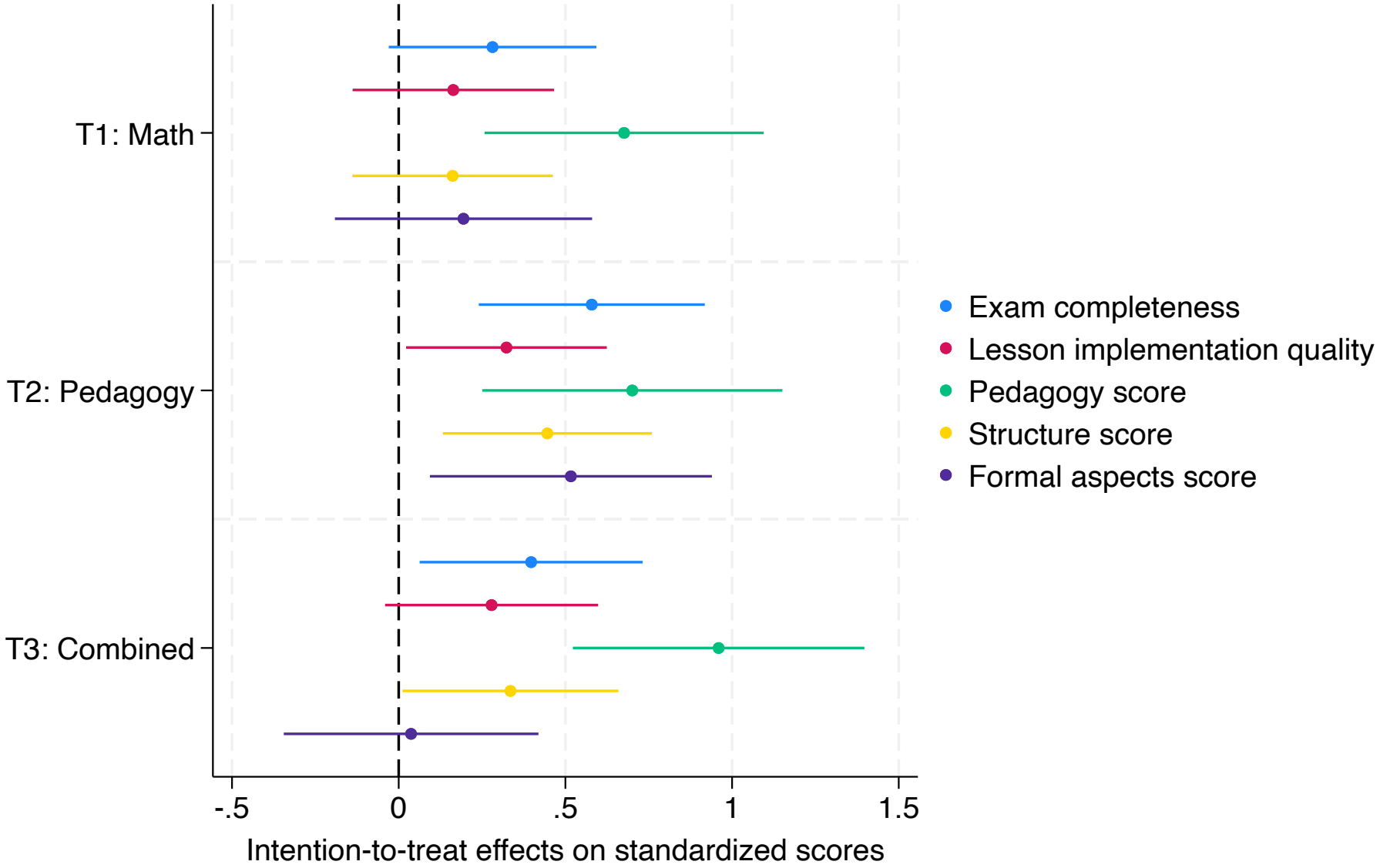
Example items (teachers)



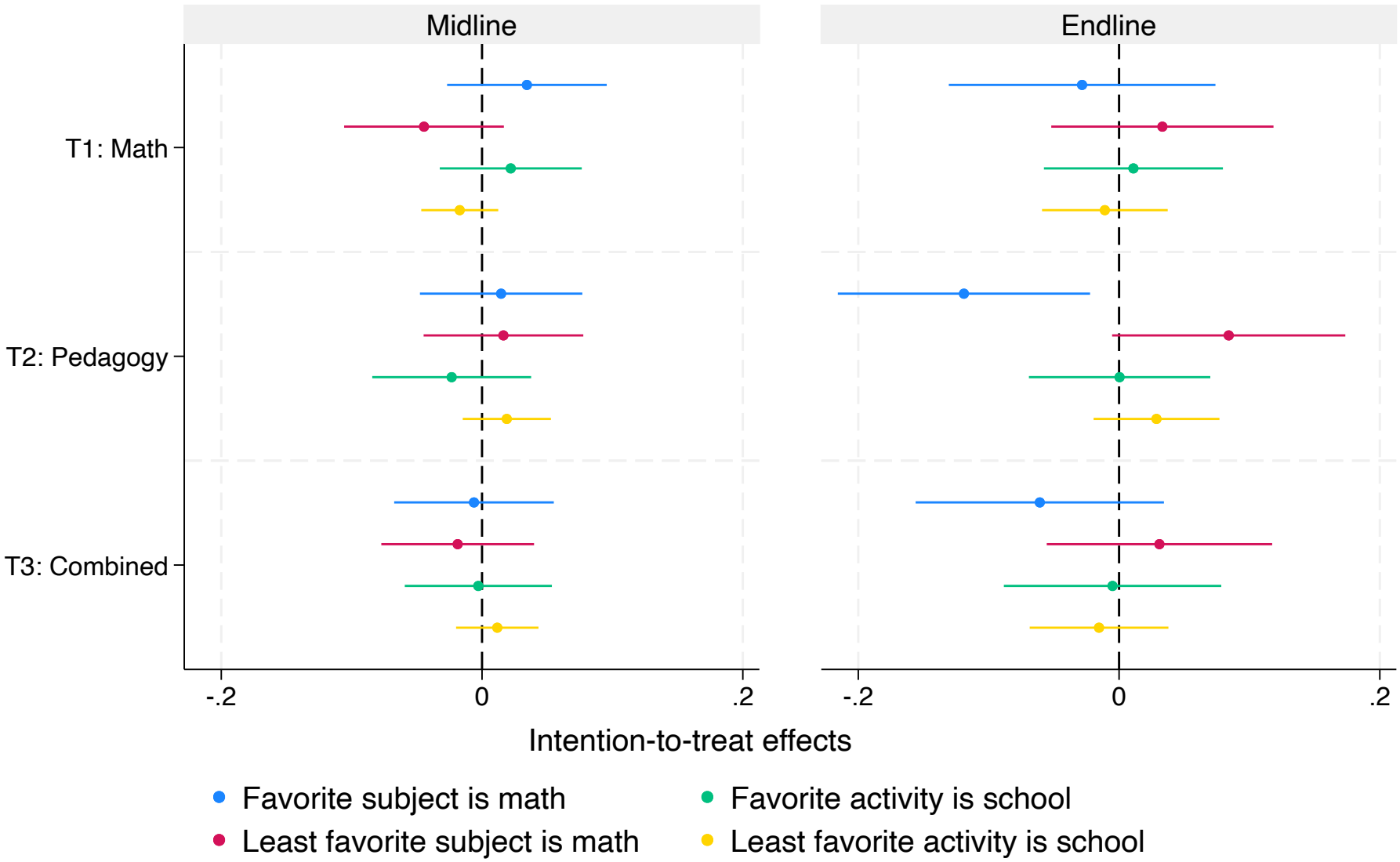
ITT effects on test scores



ITT effects on endline pedagogy test scores



ITT effects on students' attitudes



Possible explanations for small effects

- Learning deficit already too high.
  - Teaching better at 4th or 5th grade does not help much, if children do not understand basic concepts that have been introduced in earlier grades.
- No scope to adapt lesson due to strict ESMATE lesson plans.
  - Shortly before our interventions went into the field, the ministry of education introduced a new mandatory teaching plan in mathematics that left little room for adaption.

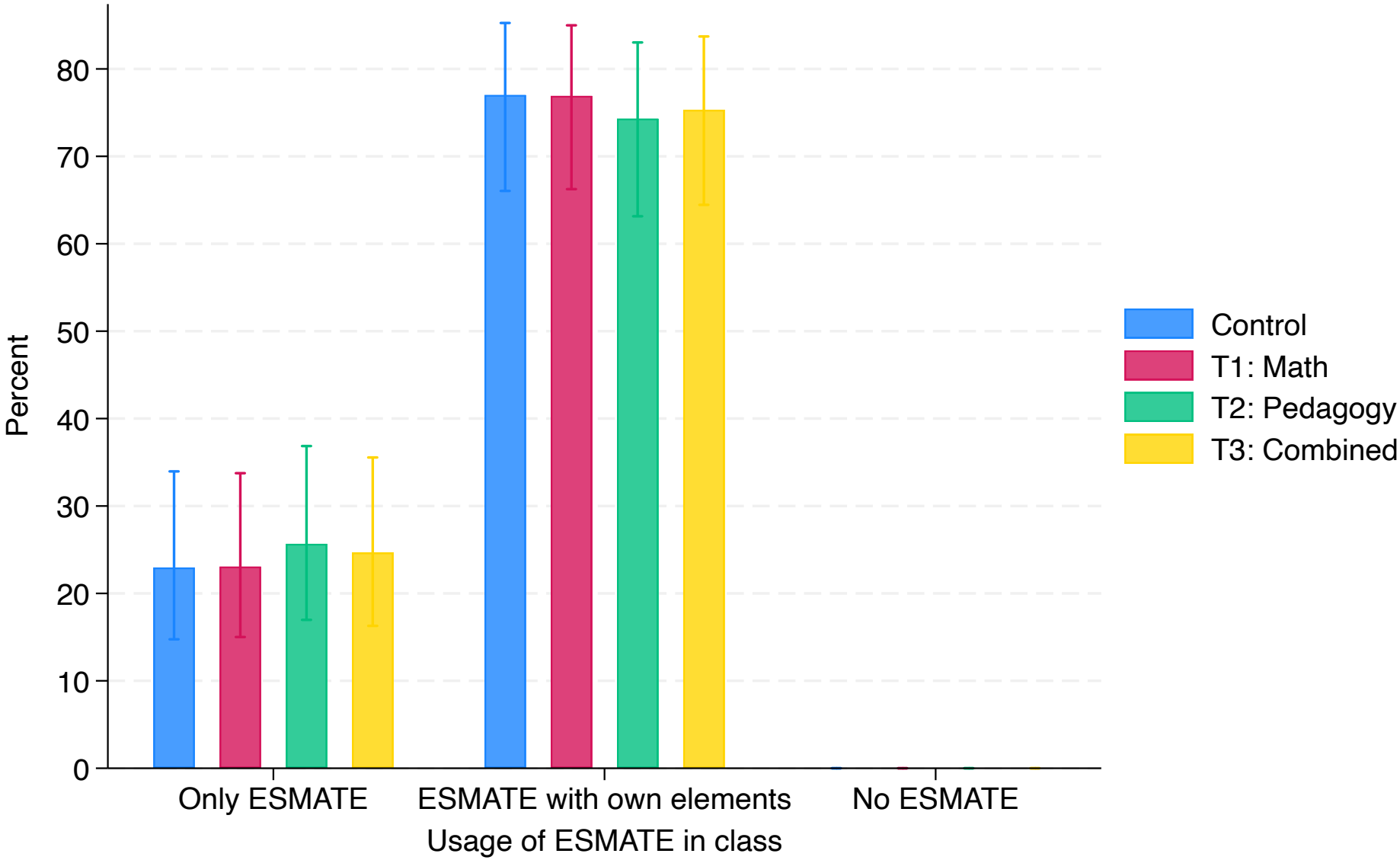
Some evidence for treatment effect heterogeneity

Effects on students' test scores by baseline competence level

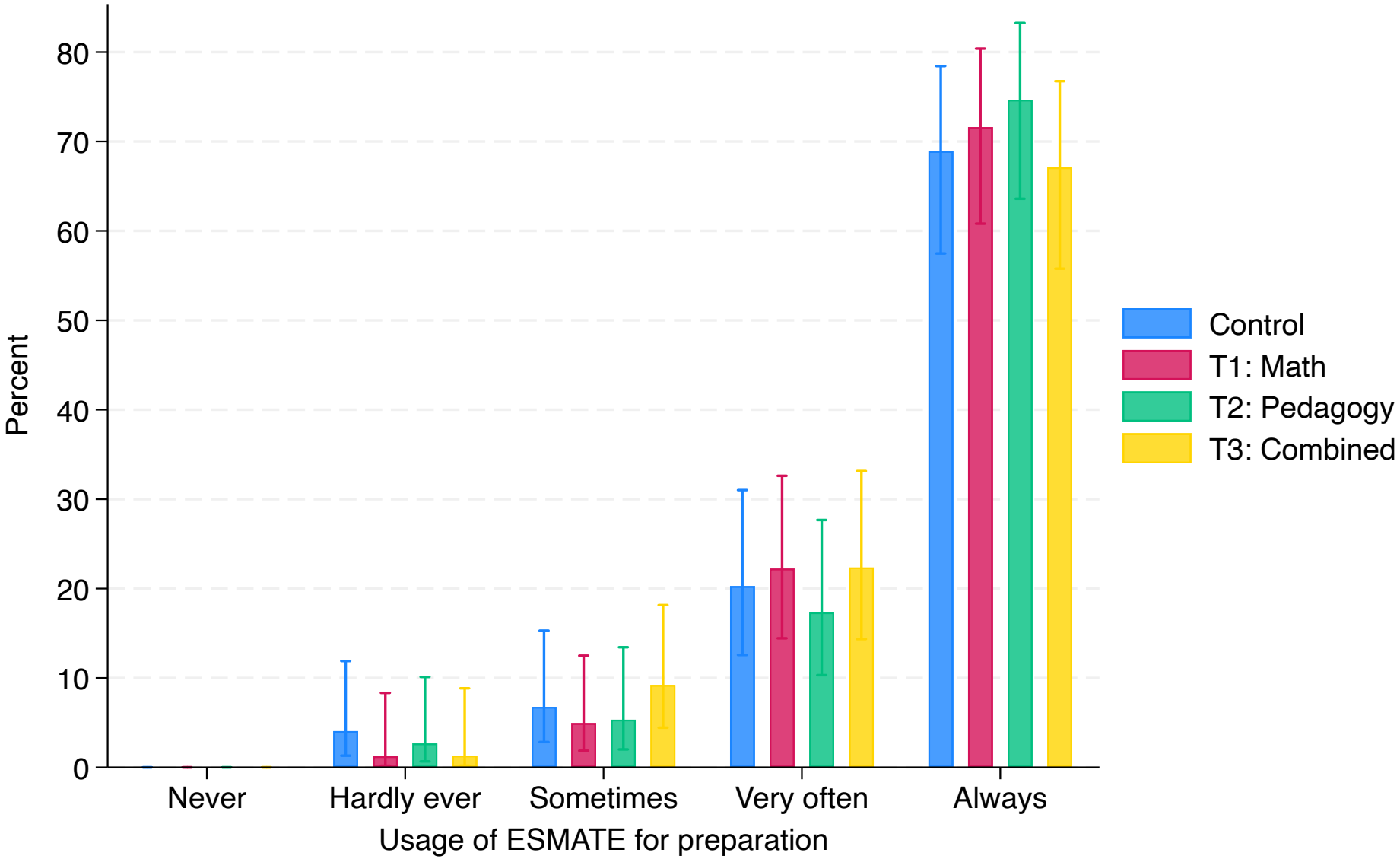
	Midline		Endline	
T1: Math	0.016	(0.061)	0.062	(0.073)
T1: Math × Baseline score	0.125^{+}	(0.064)	-0.090	(0.068)
T2: Pedagogy	-0.003	(0.070)	0.034	(0.082)
T2: Pedagogy × Baseline score	0.120^{+}	(0.068)	-0.034	(0.066)
T3: Combined	-0.079	(0.062)	-0.009	(0.089)
T3: Combined × Baseline score	0.016	(0.073)	-0.032	(0.085)
N	4342		2153	

Test scores standardized by control-group distribution; including strata fixed-effects and controls; SEs clustered by teacher ID.
$^{+}$ $p < .1$, * $p < .05$, ** $p < .01$, *** $p < .001$

Comprehensive use of ESMATE



Comprehensive use of ESMATE



Conclusions

- Although the interventions had some lasting impacts on teachers' content knowledge and pedagogical proficiency, little effect could be observed on their teaching practice or on the learning gains by their students.
- The effectiveness of teacher trainings in developing countries likely depends a lot on the context, and in our case the context might not have been beneficial.
  - Training teachers who teach at later grades might have been ineffective due to the large learning deficits that already accumulated among these students.
  - The pedagogical training could have been ineffective due to a settings with a very strict curriculum and little scope to adapt.
- In general, we believe that focus should be set on mitigating early learning deficits most effectively.

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