Title: Participant sorting in cluster randomized controlled trials: Is it happening and why does it matter?

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Background/Context

Education systems are dynamic and porous, and the movement of participants across classrooms and schools can lead to post-randomization sorting. This movement is particularly prevalent, and at times inevitable, in multi-year studies. For example, in transitioning from grade to grade, more motivated students and parents might advocate to get their students into classes of participating teachers (especially within treatment schools), thus threatening internal validity and overestimating the program's impact. Post-randomization sorting might also affect ecological validity in situations where social experiments allow for optional participation, per ethical standards, whereas the program is mandatory and sorting is not allowed in real-life settings. Given these implications, we explore the presence (or lack thereof) of sorting in one cluster (school-level) randomized control trial of a science teacher professional development program.

Purpose/Research Question

Our research aims to investigate the extent to which sorting of teachers and students occur in cluster randomized controlled trials. Pertaining to trials in which not all teachers in the school are part of the study and where joining a study post-randomization is allowed, our research questions are:

1) Are students sorting into or out of study teachers' classrooms within-schools? If so, does sorting happen similarly across schools in treatment and control conditions?
2) To what extent is sorting of teachers occurring and how might that affect internal validity? Is there a disproportionate number of joiners to the treatment condition relative to control? Are there differences in the distribution of teachers' pretest scores between the random assignment conditions? Are there differences in the distribution of teachers' pretest scores between joiners and teachers who were present at randomization?

We hypothesize that students are not sorting within-schools into study teachers' classrooms given that the program is a teacher PD program, and students/parents might not be privy to which teachers receive PD. We believe sorting is even less likely in the control condition since teachers do not receive PD. However, regarding teachers, we hypothesize that teachers will disproportionately join the study in the treatment condition since the benefits of joining (e.g. receiving PD) may be more appealing.

Setting/Population/Participants

The study took place in 66 elementary schools serving low-income students across seven school districts and two states. The study included over 2000 students and 300 upper elementary school teachers.

Intervention

The program is a teacher PD model aimed at raising students' science achievement through improving instruction. The PD focuses on the connections between science understanding, classroom practices, and literacy to support the implementation of the Next Generation Science Standards (NGSS). Teacher PD activities includes a two-week summer institute and school-year professional learning communities for two years.

Research Design

Sixty-six schools were randomly assigned to either the intervention or to BAU. Impacts were assessed on intermediate and final outcomes after two years.

Data Collection and Analysis

Students were administered a science achievement assessment and a survey of non-academic outcomes after one and two years in the study. Teachers were administered a Content Knowledge assessment at baseline (pretest) and again at the end of the study. We also collected student demographic and achievement data (baseline and during the study period) from school districts. For the analyses presented in this work, we primarily use teachers' scores on the pretest and the students' scores on the third-grade state English Language Arts (ELA) assessment as a pretest to compare incoming achievement.

To assess teacher sorting, we first examine the distribution of pretest scores by condition and by joiner status. We examine whether joiners have higher incoming achievement relative to teachers who were in the study at the time of random assignment.

With a two-year trial where impacts on students are measured over consecutive grades, we can be alerted to the possibility of student sorting if we observe that students who either remain in or join a study teacher's classroom in year 2 have higher pretest scores than students who are in a non-study teacher for both years. We test this by regressing the pretest against indicators of groups (see Table 1 for definitions of the groups as used in this analysis). We also examine whether these trends vary by condition. If it is occurring, we would expect more sorting in treatment schools because program occurrence is likely signalled. To test this, we add a dummy variable for treatment and terms for interactions between treatment and group membership to the earlier regression models.

Findings

Descriptive results for the sample of teachers reveal that the joiners were disproportionately from treatment schools (49 of 60 joiner teachers) (see Figure 1 for more detail on the study sample). The distribution of pretest scores for baseline teachers and joiners are similar (Figure 4), with a difference in mean score of .003 percentage points (.594 for teachers present at randomization; .597 for joiners), and standard deviations of .135 and .138 for teachers present at randomization and joiner teachers, respectively (Table 2).

For students, we observe that Group 1 had higher pretest scores than Group 0 by approximately .44 sd units (p<.01). Group 2 had higher pretest scores than Group 0 by approximately .34 sd units (p<.01). We find that Group 1 outperformed Group 0 on the pretest but there was a difference between treatment and control in this performance advantage: (p=.253).

Group 2 does not exhibit a similar pattern. Contrary to expectations, the treatment group in Group 2 has lower pretest scores than the control by .25 sd (*p*=.003).

Conclusions

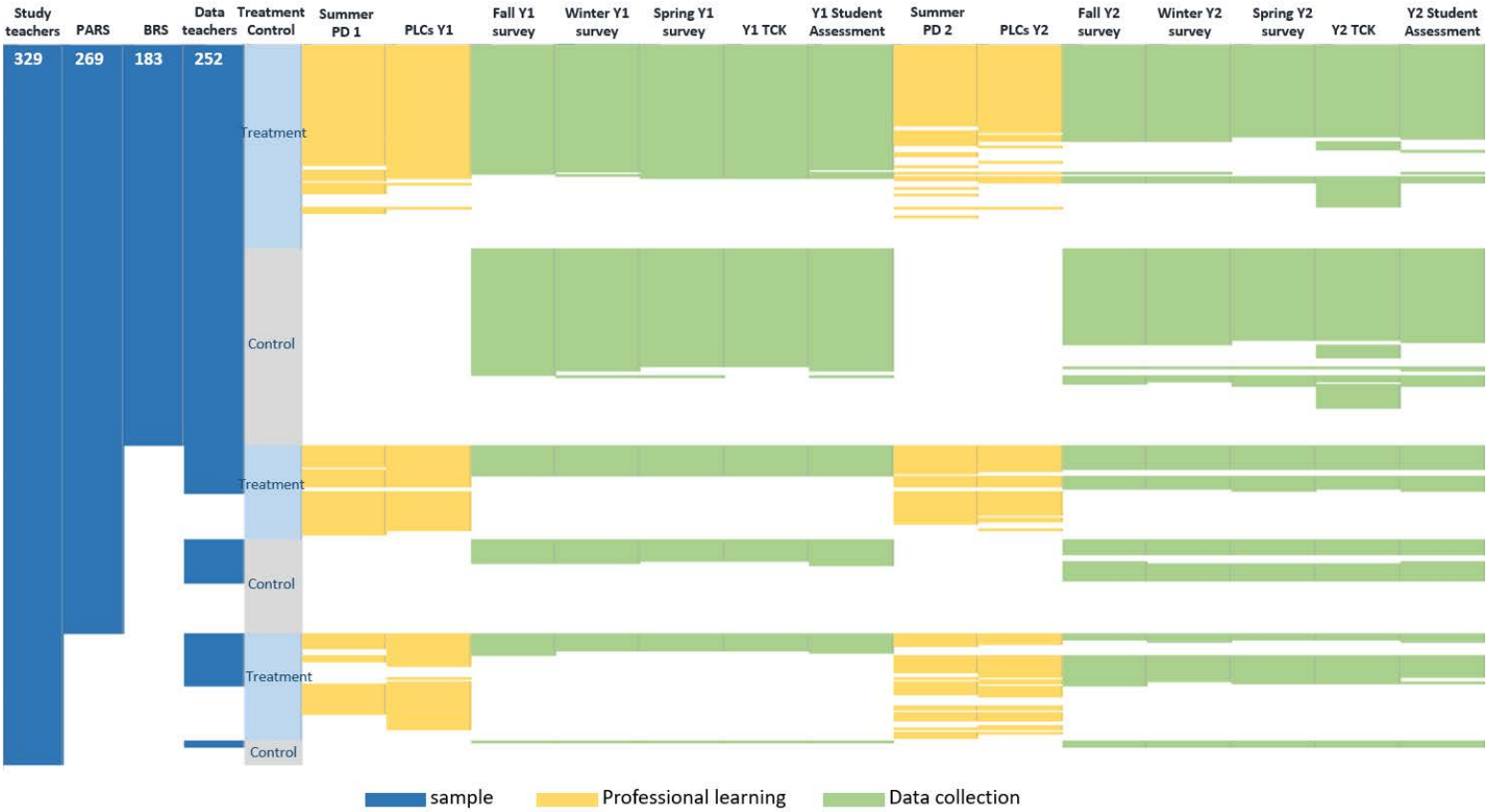
Preliminary results suggest that there may be sorting at the student level, though more investigation is needed to determine the direction of the sorting, given the surprising result among Group 2. Regarding teachers, distributions of pretest between teachers who were present at randomization and those who joined the study post-randomization show some similarities. We will continue to explore these results. For example, the student analysis corrects for clustering of students in teachers, but not in schools. We will add a school random effect. We will also expand the teacher models to include interactions with treatment.

Tables and figures

Table 1. Group classification for students' trajectory from year 1 to year 2

Group name	Group description
Group 0	In a study teacher's classroom in year 1 but were not in year 2.
Group 1	In a study teacher's classroom in both years 1 and 2.
Group 2	Not in a study teacher's classroom in year 1 but joined a study teacher's classroom in year 2.

Figure 1. Teacher sample membership, implementation, and data collection



Note: The figure provides a visual representation of the intensity with which various samples (blue columns) of teachers participated in PD (yellow columns) and completed data collection activities (green columns). Each teacher is represented by a horizontal bar. A colored cell indicates attendance/completion, while white indicates this was missing for the teacher to which the row corresponds.
PAR = Present At Randomization; BRS = Baseline Representative Sample;
PLC = Professional Learning Community;
TCK = Teacher Content Knowledge;
Y1 = Year 1; Y2 = Year 2

Table 2. Distribution of teacher pretest by joiner status

	n	Missing	Min	Max	Mean	Median	SD
Present at Baseline	**269**	**0**	**0.217**	**0.935**	**0.594**	**0.587**	**0.135**
Joiners	**60**	**0**	**0.261**	**0.957**	**0.597**	**0.587**	**0.138**

Figure 2. Distribution of pretest of all study teachers, includes teachers present at randomization and joiners

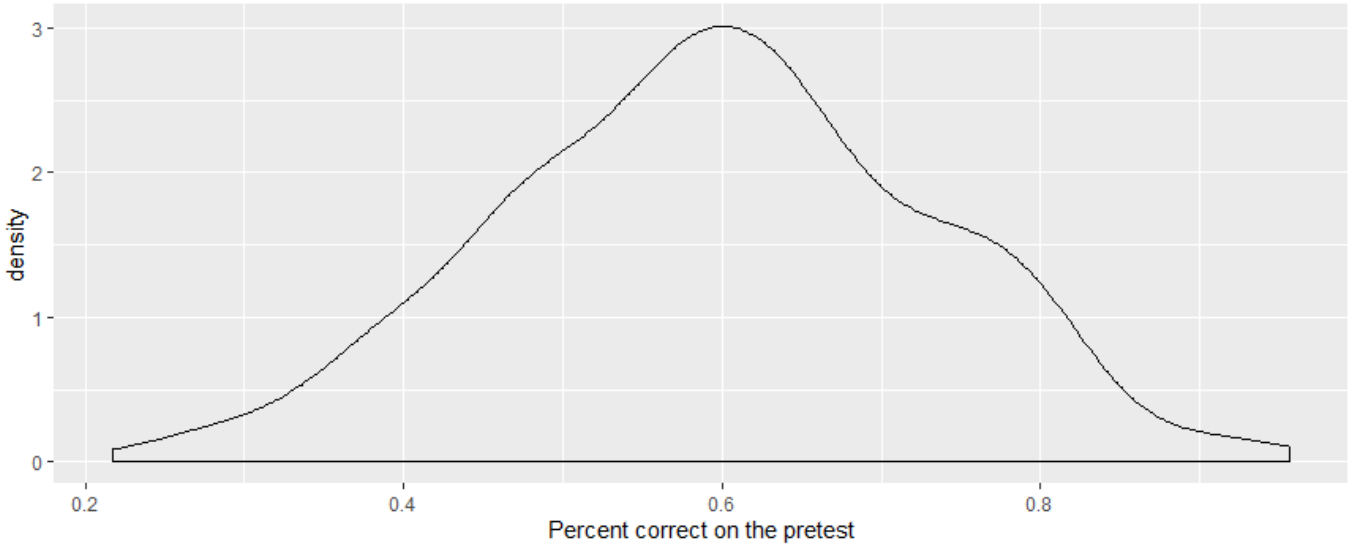


Figure 3.Distribution of pretest, by randomization status

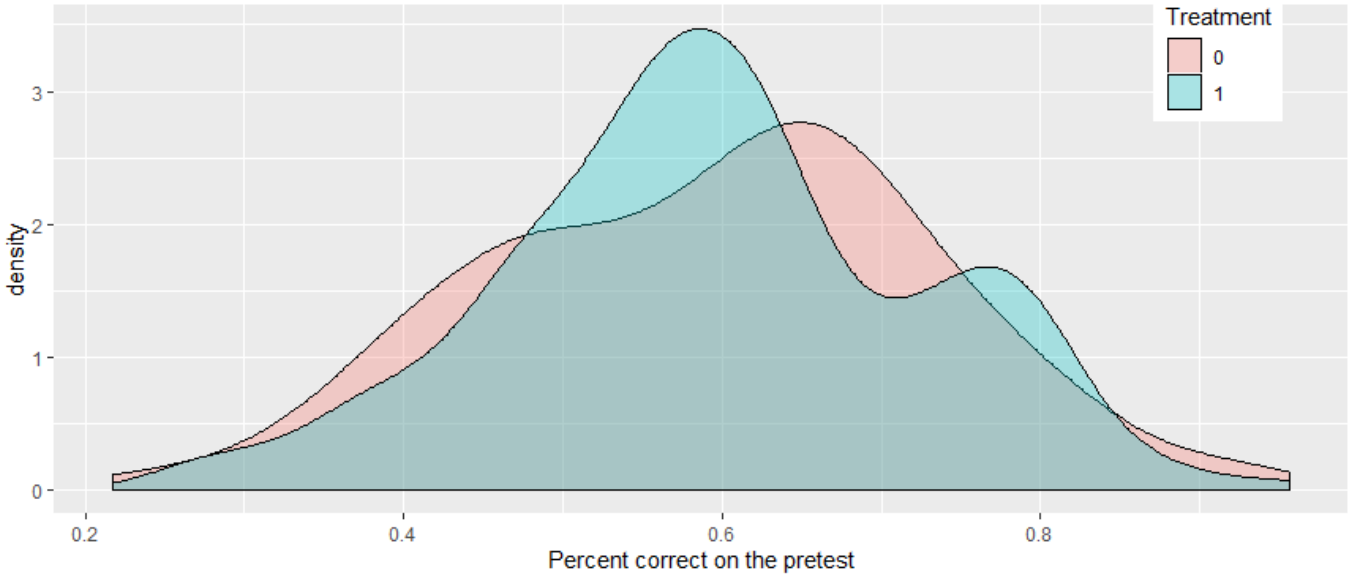


Figure 4. Distribution of pretest, by joiner status