SIER Working Paper Series No. 122

Do Teaching Practices Matter for Cooperation?

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August, 2018

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Abstract

This paper investigates the impact of a student-centered teaching pedagogy program on cooperative behaviors of 610 students in five middle schools. We combine the school-level program of changing teaching practice with laboratory experiments, implemented before and after the program, measuring changes of students' cooperation. We show that the program increased students' voluntary contributions in a linear public goods experiment and raised teamwork performance in a real-effort task where members pursue a common interest. Our findings support the idea that teaching practices stimulating interpersonal interaction among students affect the formation of cooperative norms among students.

Keywords: teaching practices, project-based learning, cooperation, field experiment, laboratory experiments

JEL: C91, C92, C93, I21

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1. Introduction

Cooperation is necessary to resolve numerous challenges facing all levels of human society and plays an essential role in building social cohesion and affecting the success or failure of organizations and communities. How to foster norms of cooperation has long been a central issue in social and behavioral sciences. For instance, game theory and its applications have focused on the roles of material incentives and long-run interactions in sustaining cooperative behavior among individuals in small and large groups (e.g., Axelrod 1984; Fudenberg and Maskin 1986; Ostrom 1990; Kandori 1992). The literature of behavioral economics and psychology has, alternatively, paid attention to non-pecuniary, often temporary, means of motivating people to behave pro-socially such as social comparison information, observability, and non-contingent gifts (e.g., Fehr et al. 1993; Frey et al. 2004; Falk 2007; Ariely et al. 2009; Yoeli et al., 2013; see also Kraft-Todd et al. (2015) for a recent survey).

We take a different approach to address this issue by investigating whether a policy intervention targeting the promotion of social interaction among individuals can cultivate cooperative norms and behaviors in a community. The expansion in the frequency and depth of human interaction can alter social ties among community members and affect their propensity to cooperate in a variety of settings. Related ideas have been discussed in the literature of social capital documenting that the decline of social engagement in a community, expressed metaphorically as “bowling alone”, was closely linked to the erosion of cooperation and participation in civic and political domains (Putnam 1995, 2000).

This paper exploits an education intervention that encourages teachers to lead their students to work in groups and do projects together and thus stimulate interpersonal interaction among students in school. The local education authority in a large city in the Republic of Korea launched the introduction of project-based learning (henceforth PBL)[1] in 2015 as a three-year program aimed at changing teaching practices of middle schools from the conventional lecture-oriented classes to “students work in groups” classes, which we refer to as horizontal teaching practices by following Algan et al. (2013).[2] We focus on the first

[1] Project-based learning can be defined as learning that is focused on projects through student centered collaboration and teamwork to solve real problems and tasks.

[2] Algan et al. (2013) classified teaching method as vertical and horizontal teaching. Vertical teaching is characterized as a teacher-centered class where teachers give lectures, students take notes, and teachers ask

year of this program in which two schools were selected as the PBL model schools. The program consists of three-day teacher training during the summer of 2015 and subsequent consultation on the implementation of horizontal teaching in classes which happened every two weeks during the fall semester 2015.

To measure the impacts of change initiated by the PBL intervention on cooperation with other students, we combine the education intervention in the field with lab experiments where students make incentivized choices. We conducted the same set of three types of laboratory experiments before and after the intervention in order to measure changes in students' propensity to cooperate with their classmates in two different economic environments. The first experiment uses two versions of dictator games in which subjects divide money between themselves and an anonymous student in his/her class or the school in order to measure individual students' preferences for giving. The second experiment utilizes a standard linear public goods game in which individuals make voluntary contributions to the public goods, which represents a situation of cooperation in social dilemmas. The third experiment, which we call group card matching game, involves a real-effort task in which groups of four students match as many quadruples of the same shape and color as possible in a fixed amount of time. Because subjects' payoffs depend on the number of successfully matched cards, the game captures a situation in which members seek to cooperate on common interests and work as a team. We also implemented an individual card matching game to control differences of individual skills of matching cards.

We find evidence that the introduction of horizontal teaching improves students' cooperation in the public goods game and teamwork in the real-effort card matching task. In the public goods game subjects who experienced the PBL classes maintained 8.3 percentage points higher cooperation rate than those who did not experience the PBL intervention. In the real-effort task of group card matching students exposed to the PBL intervention performed 0.44 matches more than the control school students. However, we do not find any significant changes on students' giving behaviors to an anonymous classmate or to their school in the dictator games. Our findings suggest that cooperation and teamwork can be promoted by such short-run intervention of increasing interpersonal interaction as our PBL intervention during one academic semester, whereas preferences for giving are not easily malleable in the short

questions to students. Horizontal teaching is characterized as a student-centered class where students study in group, do projects together, and ask questions to teachers.

run.

Our paper is closely related to Algan et al. (2013) who, using cross-country and individual-level survey data, show the correlation between teaching practices and general trust and student beliefs about cooperation. As they noted, Asian countries including the Republic of Korea have relied less on horizontal teaching practices than in Nordic and Anglo-Saxon countries. Differently from Algan et al. (2013), we combine the pedagogical intervention in schools and lab-in-the-field experiments to evaluate the impacts of horizontal teaching practices on actual cooperation in group decision-making environments with common interests and with free-riding incentives. Our paper also contributes to a growing literature of using laboratory experimental tools in evaluating policy interventions. Bettinger and Slonim (2006) measure the effects of an education voucher program on children's altruism. Attanasio et al. (2015) use linear public goods games to study the link between conditional cash transfer program and cooperation. Banks et al. (2016) and Kim et al. (2018) examine the impacts of either a compulsory school reform or a randomized experiment on education support on economic rationality and preferences by relying on experimental tools. We utilize laboratory tools in school environments to test the link of teaching practices to student cooperation.

The remainder of the paper is organized as follows. Section 2 describes the study's setting and PBL intervention program and Section 3 explains the data and lab experiments in details. After discussing the empirical strategies in Section 4, we present the results of our experiments in Section 5. Section 6 concludes.

2. Setting and Intervention Program

Daegu Metropolitan Office of Education in the Republic of Korea launched the introduction of PBL program in 2015 as a three-year program in order to encourage middle schools to change teaching practices from the conventional lecture-based classes to horizontal student-centered teaching practices which facilitate students work in groups.[3] The program mainly targeted 7th grade education curriculum, which is the first year of middle school in Korea.

[3] Daegu is the fourth largest city in the Republic of Korea, with 2.5 million residents and there are 125 middle schools in the city.

In the first year of this program in 2015, two middle schools, referred to here as school 1 and school 2, were selected as PBL model schools by Daegu Metropolitan Office of Education. School 1 did not have any prior experience in conducting PBL-type classes whereas school 2 has been independently conducting PBL-type classes since 2012. To evaluate the impacts of the PBL program, three nearby control schools were selected. The two PBL model schools (or treatment schools) and three control schools are located within a 2 km radius in the downtown area of Daegu city.

For the two PBL model schools, a PBL consulting team consisting of four experts in education and educational technology was set up to support the program. The consulting team offered teachers in two PBL model schools three-day PBL training during the summer of 2015.[4] On the first training day, focus group interviews for teachers in charge of 7th grade students were administered and PBL's key concepts and procedures were discussed. From the second day, teachers were encouraged to design their own PBL cases while learning other PBL cases. During the training session, an online blog for each PBL model school was created and 222 PBL cases in 13 subjects were provided for vicarious learning. Finally, detailed consulting and feedback sessions were followed after presenting newly designed PBL cases.

As the 2015 fall semester started, experts from the consulting team provided teachers with consulting and coaching services on the actual implementation of PBL classes throughout the semester. This semester-wide consulting intervention consisted of both online and offline components. When teachers uploaded their PBL course plans and PBL class activity video clips on the school PBL blog, experts provided online consulting and coaching in the blog. Moreover, experts visited the two PBL model schools every two weeks to provide in-person consulting while actually observing some of PBL classes in the schools. This PBL training and consulting intervention led to a significant increase in PBL class implementation among the two schools. During the 2015 fall semester, teachers from school 1 allocated 12.7 percent of their total teaching hours into PBL class (36.6 hours out of 289 hours) on average while teachers from school 2 used 12.3 percent of their total teaching hours for PBL class (35 hours out of 283.7 hours) on average.

[4] School 1 had three-day PBL training session between August 4th and August 6th, 2015 while School 2 had the training between August 10th and August 12th, 2015.

Prior to the PBL implementation in the 2015 fall semester, we visited each of the five schools in August 2015 and conducted a baseline survey for the 7th graders (aged 12~13).[5] The baseline survey was conducted with the parent's written consent and information about the student's family background was collected during the process of obtaining consent from the parents. Four months later, in December 2015, an endline survey, also with the written consent of the parents, was undertaken at the end of the fall semester. It included the same set of questions as in the baseline survey to ensure comparability. The re-contact rate was very high (97 percent) and there was no differential attrition in PBL model schools and in control schools.[6] Figure 1 summarizes the timeline of the PBL intervention and surveys.

- Figure 1 here -

3. Data and Lab-in-the-field Experiments

The baseline and endline surveys consisted of three parts; 1) lab experiments, 2) cognitive tests, and 3) general questionnaire. Each part lasted for an hour. In the first hour, we administered a series of incentivized experiments. In the second hour, students took Raven's progressive matrices tests consisting of 10 problems and an academic achievement test on four subjects (Korean, English, Math, and Science). Students were asked to answer five questions in each subject and thus in total 20 questions in the four subjects. In the last hour, we conducted a short survey on students' demographic and socioeconomic information as well as big-5 personality traits.

For the lab experiments, we administered the following experimental games: 1) two variants of dictator games, 2) public goods game, and 3) card matching games. First, we use two versions of dictator games to measure students' preferences for giving. In the first dictator game, students were given KRW 2,000 and were asked to allocate the endowment

[5] 7th grade is the entering grade in a middle school in the Republic of Korea. Middle schools consist of 7th, 8th, and 9th grade.

[6] The total enrollment number of 7th grade students across five schools was 675. Out of 675, 649 students participated in the baseline survey (96.1 percent). Among 649 baseline students, 632 students were re-contacted during the endline survey (97.4 percent).

between themselves and an anonymous student within the classroom.[7] In the second dictator game, students again were given KRW 2,000 and were asked to allocate the endowment between themselves and school. Students were informed in advance that their donation to school would be used for a variety of students' welfare activities. We consider that the donation amounts in these two dictator games can reflect students' other-regarding preferences towards either an anonymous student in class or school.

Second, we utilize a standard linear public goods game in which individuals make voluntary contributions to the public goods, where there is an incentive of free riding. Each student in a classroom was given KRW 2,000 and asked to allocate the endowment between a private account and the public account. Students were informed that any amount put in the private account would be directly attributed to their payoffs and that every student in a class would receive 10% of the total amount put in the public account.[8] We interpret that the amount of money students contribute to the public account can reflect the level of cooperation and trust with each other for a common good when there is a free-riding incentive. Since any deviation from the dominant strategy of giving zero in a standard linear public goods game could also be due to altruism or confusion, we control for altruism measured in dictator games and for confusion by including students' cognitive abilities.[9]

Third, a card matching game involves a real-effort task in which groups of four students match as many quadruples of the same shape and color as possible in a fixed amount of time.[10] Each student was endowed with 20 cards in the beginning. While holding 20 cards in hands, not being allowed to show his or her cards to others, each student was able to open at most three cards on the table at any moment of the game. Then, students figured out other students' card information through verbal communication to match quadruples. Matched

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[7] As of August 2015, the exchange rate of US dollar to Korean Won (KRW) was approximately 1,020.

[8] Since each class consists of about 20 to 25 students, the multiplication factor ranges from 2 to 2.5. The total payoff can be maximized when every student in a class contributes all their endowment to a public account, while the unique Nash equilibrium with self-regarding preference predicts that they do not contribute to a public account at all.

[9] It is well known that human subjects tend to depart from the Nash equilibrium prediction by making positive contribution. The literature attributes this behavior to a variety of sources, including other-regarding preferences, reciprocity, or pure mistakes (see Ledyard 1995).

[10] Students were given one and a half minutes to discuss how to efficiently play the group card matching game, and then three minutes for the actual game. The reason we set the group number to equal four is because the PBL within classroom is mostly based on a group of four students.

quadruple cards were put into a collection bag and were examined whether they were correct matches or not after the game. As a group, there were 10 matched quadruples and 40 remainder cards. Each student received 10 cards, each of which was a part of different matched quadruples, and 10 remainder cards. Students were given KRW 100 for one correct quadruple match and were lost KRW 100 for each incorrect match. Thus, the maximum payoff for group card matching game was KRW 1,000. Because students' payoffs depend on the number of successfully matched quadruples, the game captures a situation in which members seek to cooperate on common interests. In order to control students' different skills of matching cards, we also conducted an individual card matching game prior to the group card matching game. Each student was given a deck of 50 cards which consisted of 10 matched pairs and 30 remainders in the individual card matching game and one minute was given to students to find as many matched pairs as possible. Students were also given KRW 100 for one correct match and were lost KRW 100 for each incorrect match. We interpret the performance of the group card matching game after controlling for the individual card matching performance as a measure for cooperation or teamwork in a real-effort situation. After the study was completed, students received actual payments from the experiments in the form of school coupons which are valid in their school convenient store. We present the experimental instructions given to students in Online Appendix A.[11]

Panel A of Table 1 shows the descriptive statistics on experimental outcomes in the baseline study for the sample constructed with 610 students from 26 classrooms of five schools who participated in both the baseline and endline surveys.[12] The average donation share in two dictator games were 32.4 percent and 35.3 percent of their endowment to an anonymous peer in class and to school, respectively while students donated on average 37.5 percent to the public account in the public goods game. According to a meta-analysis using 131 studies on dictator game, dictator gives 28.4 percent of his/her endowment on average

[11] Three lab experiments were conducted in the following order. We administered dictator games and public goods game first. The order of dictator games and public goods game were randomized. However, among the two individual dictator games, the dictator game for anonymous classmates was conducted first and then the game for the school was played. After completing dictator games and public goods game, we lastly administered the card matching games.

[12] During the endline survey, the experimental protocol for the public goods game was violated in one classroom of a control school (school 3). The class leader spoke out his intention of donating all the endowment to the public account, which influenced other students' decisions. We exclude 22 students in this classroom from the sample and restrict our sample from 632 students to 610 students.

(Engel, 2011). The average donation share in our study is similar to the findings of the literature where participants are students in school.[13] Another meta-analysis of 27 studies on linear public goods game shows that the average shares of contribution is 37.7 percent, which is close to our results (Zelmer, 2003). For the group card matching game, each group matched 5.6 quadruples on average.[14]

In Panel B of Table 1, we report student baseline characteristics. We have more boys than girls in our sample and 67.5 percent of the sample are boys since school 1 and school 3 are single-sex schools only for boys. Around the half (50.5 percent) of the sample are first-born children and their parents are in their mid-forties on average. Regarding the parents' education background, 45.6 percent of fathers and 38.5 percent of mothers finished college education.

- Table 1 here -

4. Empirical Strategy

To examine the causal effect of the PBL program on cooperative behavior and giving behavior, we consider the following difference-in-differences model:

$$Y_{icst} = \beta_1 PBL_{st} + \beta_2 X_{icst} + \gamma_{cs} + \eta_t + \varepsilon_{icst} \quad (1)$$

Y_{icst} indicates an outcome of interest for student i in classroom c of school s at time t.[15] PBL_{st}

[13] Goeree et al. (2010) reported that dictator students (grade 5 and 6) donated 34 percent of their endowment on average to another student in their school.

[14] Due to heterogeneous class sizes, we have residual groups with less than four members for the group card matching game in some classrooms (5.4 percent of the sample). We use the whole sample throughout the paper. When we restrict the sample only to group of four students, the results on the group card matching game remain similar to the full sample analysis.

[15] In middle schools in Korea, students sit in their own classrooms and the classes are taught in a way that teachers move around various classrooms. Therefore, students belonging to the same classroom share the same classes taught by the same teachers. Considering that the treatment of interest in this study is a change in the way classes are taught, it can be understood that students belonging to the same classroom are exposed to the same treatment.

represents a dummy variable indicating whether the PBL program was implemented in school *s* at time *t*. For three control schools, we code PBL_{st} equals always zero. For two treatment schools, $PBL_{t=0} = 0$ and $PBL_{t=1} = 1$. X_{icst} is a vector of predetermined characteristics of students such as gender, number of siblings, birth order (first-born), parents' age, parents' education, household monthly income, religion, cognitive ability (measured by Raven test and an academic achievement test), and big-5 personality traits, all of which are measured in the baseline survey conducted prior to the beginning of the PBL program. γ_{cs} and η_t represent classroom-by-school and time fixed effects, respectively. The classroom-by-school fixed effects control all the classroom-level time-invariant confounders, either observable or unobservable, that may affect the outcome of interest such as class size and student composition. Although not explicitly shown in equation (1), we also include a list of dummies for each of eight experimenters (experimenter fixed effects) in all of our regression analyses in order to control for the possibility that the value of the outcome variables may depend on the way each experimenter conducted the experiments and surveys. Finally, ε_{icst} denotes an error term.

The coefficient β_1 compares the change in the outcome of interest (e.g., cooperative behavior of students) of students engaged in the change of teaching method in their school with that of their peers without such a change over a semester (difference-in-differences). We interpret β_1 as reflecting the causal effect of the horizontal teaching practices on the outcomes of interest including cooperative behaviors of students. We estimate equation (1) with the ordinary least square (OLS) method and cluster the standard errors at the level of full interactions among school, class, and survey time (52 clusters in total).

As discussed in Section 2, one of the treatment schools (school 2) had independently conducted PBL-type classes since 2012. Thus, 7^{th} grade students from school 2 are likely to already experience horizontal teaching classes in their 2015 spring semester (the first semester in middle school of the students participating in this study) before the baseline survey. This difference on the initial teaching practice condition between the treatment schools may lead to heterogeneous treatment effects if the exposure to horizontal teaching has a nonlinear treatment response. Thus, we report the impacts of horizontal teaching not only for the overall treatment schools (both school 1 and school 2 combined) but also for each treatment school.

5. Results

5.1. The Effect on Giving Behavior

We begin by examining the impacts of the horizontal teaching intervention on giving behavior in the dictator games. Table 2 summarizes the estimation results of equation (1) where the share of donation to an anonymous student in class is used as the dependent variable. For an expositional purpose, we only report the coefficient estimates for the treatment indicator (PBL_{st}) and the time dummy (η_t) in equation (1). The full estimation results are reported in the Online Appendix B.

- Table 2 here -

Panel A of Table 2 shows the results when both school 1 and school 2 are used as treatment group. Panel B and C of the table report the results when treatment group is restricted to school 1 and school 2, respectively. In each panel, column 1 reports the estimation results without any baseline covariates. In column 2, we control for demographic characteristics of students. In column 3, we further control for cognitive skills measured by Raven and academic achievement tests and non-cognitive traits captured by a ten-item measure of the Big Five personality dimensions. Our preferred specification is reported in column 3 with the full control variables.

The results of Panel A in Table 2 (two treatment schools vs. control schools) show that there is no significant effect of the PBL intervention on the amount of donation shared with an anonymous classmate. The estimated effects of the horizontal teaching program are all small in magnitude and statistically insignificant regardless of the choice of covariates. Interestingly, we find significant and substantial negative time effects; students tend to donate 18.2 percentage points less in the endline survey than they did in the baseline survey. This negative time effects consistently appear throughout the two variants of dictator games as well as the linear public goods game. We conjecture that it is driven by subjects' learning through the repetition of the same games between the baseline survey and the endline survey. The experimental literature similarly reports the negative effects of the repetition of games in the laboratory on giving behavior and contribution behavior in public goods games (see Engel 2011; Ledyard 1995). Hence, we measure treatment effects conditioning on learning effects common in both treatment and control schools. Panel B and C of Table 2 show a

similar pattern to those observed in Panel A of the table; students tend to donate less in the endline survey than they did in the baseline survey and the horizontal teaching program did not significantly affect the share of donation to anonymous classmate.

Table 3 shows the estimation results of equation (1) where the share of donation to school is used as the dependent variable. As in Table 2 for the share of donation to anonymous classmate, we do not find any significant impact of the horizontal teaching intervention on donation behavior toward the school neither for the overall treatment impacts (Panel A) nor for the heterogeneous treatment impacts between two treatment schools (Panel B and Panel C). Overall we conclude that the one-semester horizontal teaching intervention does not significantly change students' preferences for giving toward an anonymous classmate or toward their school.[16]

- Table 3 here -

5.2. The Effect on Cooperation and Teamwork

We next turn to our primary interests on the effects on cooperation and teamwork. Table 4 reports the regression results on the impacts of the horizontal teaching intervention on cooperation in the public goods game measured by the share of contribution to the public account. As in Table 2 and Table 3, column 1 summarizes the results from the most parsimonious specification column 2 reports the results when demographic characteristics of students are controlled, and column 3 shows the results when the baseline cognitive abilities and non-cognitive traits are additionally controlled. Differently from Table 2 and Table 3, we further control for students' baseline donation amounts from two dictator games in column 4 considering that cooperative behavior from the public goods game can be driven by individual students' other-regarding preference, which are our preferred specification.

- Table 4 here -

[16] Although statistically insignificant, the estimated effects on the donation to school in Table 3 are all negative, while those for anonymous classroom peer in Table 2 are all positive. Given that the dictator game toward school was played immediately after the dictator game to anonymous classroom peer, the observed negative effects on donation to school may reflect mean reversion in giving behavior of students, although it is hard to test the validity of this interpretation given the research design of this study.

As in Table 2 and Table 3, we also find a significant and substantial over-time decrease in share of contribution to the public account by 15.7 percentage points (column 4 of Panel A). However, the decrease in the public goods provision was observed to be 8.3 percentage points (in share of contribution) smaller among students engaged in the horizontal teaching intervention, suggesting that horizontal teachings induced students to be more cooperative with their classmates. This result is statistically significant at the 5 percent level, which remains unchanged throughout the different specifications. Overall, our results suggest that horizontal teaching improves students' cooperation within a classroom in the environment of public goods provision with free-riding incentives.

Interestingly, the effect size of horizontal teaching on public-goods game for school 1 (0.121 from Panel B, column 4) is bigger than that of school 2 (0.063 from Panel C, column 4) by almost a factor of two. The heterogeneous treatment effects between school 1 and school 2 suggest that the exposure to horizontal teaching may have a concave treatment response. Since it was the first time for school 1 students to experience PBL-type horizontal teaching practice, the slope of the treatment response could be rising sharply. However, school 2 students already experienced similar teaching practice during the 2015 spring semester before the baseline and their slope of the treatment response to the intervention was flatter than school 1 students. Of course, data from more than two points of time, which are unavailable for this study, would be required to empirically test this hypothesis.

We also examine the impact of horizontal teaching intervention on students' cooperative behaviors in the real-effort task where team members have a common interest of card matching. We measure the degree of cooperation among a group of students as their group card-matching performance after controlling for their individual card-matching performance. In columns 1 through 3 of Table 5, we begin by estimating the effect of the horizontal teaching intervention on performance in individual card matching task. We find that the horizontal teaching intervention did not significantly affect individual skills in this particular card matching task. However, we see a significant over-time increase in individual card-matching performance; students tend to match 0.66 cards more in the endline survey perhaps because the card-matching skills of students were improved as repeating the same task twice. Cognitive skills of students are also found to be significantly correlated with individual card-matching performance (shown in Online Appendix B), suggesting that students with higher cognitive skills perform better in the simple card-matching task.

- Table 5 here -

From columns 4 to 6 of Table 5 present the impact of horizontal teaching on performance in group card matching task where cooperation and teamwork are required. Contrary to the results on the individual card-matching game performance in columns 1 through 3, we find suggestive evidences on positive impact of the horizontal teaching intervention. The horizontal teaching intervention improved group card performance by 0.44 matches after controlling for performance in the baseline individual card-matching task (statistically insignificant), which amounts to 7.9 percent increase relative to the baseline average of 5.59 matches. When we look at the impact for school 1 (Panel B), we have much bigger and statistically significant increase on the group card-matching performance. However, we do not have any impact for school 2 (Panel C). These results are consistent with the concave treatment response on the results of the public goods game shown in Table 4 and suggest that the PBL-style horizontal teaching intervention can affect team cooperation in real-effort environments as well.

6. Conclusion

This paper has reported evidence on the impacts of the introduction of PBL-style horizontal teaching practices facilitating interpersonal interaction on cooperation among first-year middle school students. We relied on policy intervention of local education office to change teaching practices of two middle schools and laboratory experimental tools to measure cooperative behavior and outcomes in the two controlled distinct environments. The first experiment uses voluntary contribution decisions in a linear public goods game where free-riding incentives are prevalent. The second experiment involves card matching tasks in groups of four students who have a common material interest for cooperation. We also measured students' preferences for giving toward anonymous classmate and school as a whole using two variants of dictator game.

We found that the policy intervention of introducing student-centered horizontal teaching increases cooperation and teamwork in both public goods game and real-effort card matching game. The increase in cooperation and teamwork in the classroom was consistently observed in both of the two PBL model schools, but the magnitude tended to be larger in one treatment

school which has no prior exposure to the PBL-type classes. On the other hand, we did not find any clear evidence that the horizontal teaching intervention significantly affected preferences for giving in both of the two dictator games. These findings suggest that cooperation and teamwork can be promoted by such short-run intervention of increasing interpersonal interaction as our PBL-type horizontal teaching intervention during one academic semester, whereas preferences for giving measured by dictator games are not easily malleable in the short run.

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Figure 1. Timeline of Intervention Program

	Before the 2015 Fall Semester	During the 2015 Fall Semester	At the End of the 2015 Fall Semester
PBL Intervention	Teacher Training School 1: August 4^{th}~6^{th} School 2: August 10^{th}~12^{th}	Regular Consulting and Coaching	
Experiment and Survey	Baseline Study: August 20^{th}~24^{th}		Endline Study: December 21^{th}~24^{th}

Table 1. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Panel A: Experiments					
Dictator game results					
Donation to anonymous peer in class (share of amount)	610	0.324	0.244	0	1
Donation to school (share of amount)	610	0.353	0.309	0	1
Public-goods game result					
Investment in public account (share of amount)	610	0.375	0.299	0	1
Card-matching game results					
Group performance (number of matched quadruples)	610	5.591	2.864	0	10
Individual performance (number of matched pairs)	610	2.987	2.165	0	10
Panel B: Students and Schools					
Male	610	0.675	0.469	0	1
Number of siblings	610	1.962	0.711	1	6
First-born	610	0.505	0.500	0	1
Father's age (years)	610	45.76	4.103	32	71
Mother's age (years)	610	43.02	3.853	28	59
Father college educated	610	0.456	0.498	0	1
Mother college educated	610	0.385	0.487	0	1
Monthly income (KRW 10,000)	610	374.3	284.8	1	3,000
Having a religion	610	0.602	0.490	0	1
Raven test scores (0-10)	610	8.064	1.670	0	10
Academic achievement (0-20)	610	10.73	4.395	2	20
Big 5 Personality: Extraversion	610	3.497	0.962	1	5
Big 5 Personality: Agreeableness	610	3.218	0.723	1	5
Big 5 Personality: Conscientiousness	610	3.272	0.826	1	5
Big 5 Personality: Emotional stability	610	2.889	0.772	1	5
Big 5 Personality: Openness	610	3.513	0.821	1	5
School 1 (Treatment)	610	0.182	0.386	0	1
School 2 (Treatment)	610	0.305	0.461	0	1
School 3 (Comparison)	610	0.141	0.348	0	1
School 4 (Comparison)	610	0.241	0.428	0	1
School 5 (Comparison)	610	0.131	0.338	0	1

Notes: Summary statistics at the baseline survey are presented. Units are in parenthesis. If not specified, all variables are dichotomous indicators. For Raven test scores, we impute five missing observations with the median value. For Academic achievement, we replace one missing observation with the median value. Also for the big five personality variables, we impute six, three, six, four and three missing values respectively using corresponding median values.

Table 2. Horizontal Teaching and Donation to Peer

	(1)	(2)	(3)
Outcome variable	Share of donation to peer		
	Panel A: School 1 and 2 vs. control schools		
Horizontal teaching	0.0131	0.0133	0.0143
	(0.0238)	(0.0241)	(0.0243)
Endline survey	-0.187***	-0.185***	-0.182***
	(0.0174)	(0.0242)	(0.0227)
Observations	1,220	1,220	1,220
Demographic controls	x	o	o
Further controls	x	x	o
	Panel B: School 1 vs. control schools		
Horizontal teaching	0.00593	0.00608	0.00706
	(0.0405)	(0.0415)	(0.0419)
Endline survey	-0.182***	-0.182***	-0.179***
	(0.0182)	(0.0268)	(0.0255)
Observations	848	848	848
Demographic controls	x	o	o
Further controls	x	x	o
	Panel C: School 2 vs. control schools		
Horizontal teaching	0.0183	0.0177	0.0189
	(0.0234)	(0.0233)	(0.0235)
Endline survey	-0.189***	-0.190***	-0.186***
	(0.0177)	(0.0255)	(0.0236)
Observations	998	998	998
Demographic controls	x	o	o
Further controls	x	x	o

Notes: Demographic controls include gender, number of siblings, birth order (first-born dummy), parents' age, parents' education, household monthly income, and religion. Further controls include raven test, academic achievement tests, and big-five personality traits. All control variables were measured at the baseline survey which was conducted before the intervention. All regressions include a list of dummies for each class in each school (class fixed effects) and a list of dummies for each experimenter (experimenter fixed effects). Standard errors are clustered at the level of full interactions among school, class, and survey time (52 clusters in total). Significance *** (1%), ** (5%), * (10%).

Table 3. Horizontal Teaching and Donation to School

	(1)	(2)	(3)
Outcome variable	Share of donation to school		
	Panel A: School 1 and 2 vs. control schools		
Horizontal teaching	-0.0535*	-0.0476	-0.0475
	(0.0300)	(0.0318)	(0.0320)
Endline survey	-0.174***	-0.154***	-0.153***
	(0.0222)	(0.0276)	(0.0267)
Observations	1,220	1,220	1,220
Demographic controls	x	o	o
Further controls	x	x	o
	Panel B: School 1 vs. control schools		
Horizontal teaching	-0.0478	-0.0409	-0.0405
	(0.0495)	(0.0513)	(0.0516)
Endline survey	-0.169***	-0.148***	-0.147***
	(0.0232)	(0.0309)	(0.0290)
Observations	848	848	848
Demographic controls	x	o	o
Further controls	x	x	o
	Panel C: School 2 vs. control schools		
Horizontal teaching	-0.0559*	-0.0499	-0.0496
	(0.0293)	(0.0310)	(0.0313)
Endline survey	-0.179***	-0.157***	-0.156***
	(0.0223)	(0.0284)	(0.0272)
Observations	998	998	998
Demographic controls	x	o	o
Further controls	x	x	o

Notes: Demographic controls include gender, number of siblings, birth order (first-born dummy), parents' age, parents' education, household monthly income, and religion. Further controls include raven test, academic achievement tests, and big-five personality traits. All control variables were measured at the baseline survey which was conducted before the intervention. All regressions include a list of dummies for each class in each school (class fixed effects) and a list of dummies for each experimenter (experimenter fixed effects). Standard errors are clustered at the level of full interactions among school, class, and survey time (52 clusters in total). Significance *** (1%), ** (5%), * (10%).

Table 4. Horizontal Teaching and Public-Goods Game

	(1)	(2)	(3)	(4)
Outcome variable	Share of investments in public account			
	Panel A: School 1 and 2 vs. control schools			
Horizontal teaching	0.0816**	0.0847**	0.0850**	0.0833**
	(0.0315)	(0.0326)	(0.0330)	(0.0327)
Endline survey	-0.163***	-0.152***	-0.151***	-0.157***
	(0.0251)	(0.0275)	(0.0273)	(0.0276)
Observations	1,220	1,220	1,220	1,220
Demographic controls	x	o	o	o
Further controls	x	x	o	o
Dictator games	x	x	x	o
	Panel B: School 1 vs. control schools			
Horizontal teaching	0.122***	0.122***	0.123***	0.121***
	(0.0420)	(0.0440)	(0.0446)	(0.0441)
Endline survey	-0.150***	-0.148***	-0.146***	-0.152***
	(0.0265)	(0.0296)	(0.0292)	(0.0296)
Observations	848	848	848	848
Demographic controls	x	o	o	o
Further controls	x	x	o	o
Dictator games	x	x	x	o
	Panel C: School 2 vs. control schools			
Horizontal teaching	0.0604**	0.0642**	0.0648**	0.0630**
	(0.0292)	(0.0307)	(0.0309)	(0.0307)
Endline survey	-0.176***	-0.162***	-0.160***	-0.167***
	(0.0251)	(0.0280)	(0.0280)	(0.0283)
Observations	998	998	998	998
Demographic controls	x	o	o	o
Further controls	x	x	o	o
Dictator games	x	x	x	o

Notes: Demographic controls include gender, number of siblings, birth order (first-born dummy), parents' age, parents' education, household monthly income, and religion. Further controls include raven test, academic achievement tests, and big-five personality traits. All control variables were measured at the baseline survey which was conducted before the intervention. Column 4 further controls for students' predetermined giving behavior measured by the two dictator games. All regressions include a list of dummies for each class in each school (class fixed effects) and a list of dummies for each experimenter (experimenter fixed effects). Standard errors are clustered at the level of full interactions among school, class, and survey time (52 clusters in total). Significance *** (1%), ** (5%), * (10%).

Table 5. Horizontal Teaching and Card-Matching Performance

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Individual performance			Group performance		
	Panel A: School 1 and 2 vs. control schools					
Horizontal teaching	0.0253	0.00425	-0.0102	0.478	0.439	0.438
	(0.181)	(0.192)	(0.195)	(0.304)	(0.306)	(0.307)
Endline survey	0.774***	0.712***	0.666***	0.441*	0.402	0.393
	(0.132)	(0.197)	(0.205)	(0.233)	(0.303)	(0.316)
Individual performance				0.0899***	0.0903***	0.0914***
				(0.0287)	(0.0291)	(0.0303)
Observations	1,220	1,220	1,220	1,220	1,220	1,220
Demographic controls	X	o	o	x	o	o
Further controls	X	x	o	x	x	o
	Panel B: School 1 vs. control schools					
Horizontal teaching	-0.0370	-0.110	-0.121	0.868*	0.865*	0.871*
	(0.161)	(0.171)	(0.175)	(0.453)	(0.439)	(0.442)
Endline survey	0.847***	0.637***	0.604***	0.399	0.447	0.455
	(0.132)	(0.204)	(0.218)	(0.241)	(0.313)	(0.325)
Individual performance				-0.0370	-0.110	-0.121
				(0.161)	(0.171)	(0.175)
Observations	848	848	848	848	848	848
Demographic controls	X	o	o	x	o	o
Further controls	X	x	o	x	x	o
	Panel C: School 2 vs. control schools					
Horizontal teaching	0.0799	0.0721	0.0555	0.239	0.173	0.179
	(0.230)	(0.238)	(0.243)	(0.300)	(0.308)	(0.309)
Endline survey	0.739***	0.718***	0.662***	0.542**	0.455	0.472
	(0.136)	(0.215)	(0.224)	(0.224)	(0.298)	(0.310)
Individual performance				0.0996***	0.0961***	0.103***
				(0.0334)	(0.0341)	(0.0344)
Observations	998	998	998	998	998	998
Demographic controls	X	o	o	x	o	o
Further controls	X	x	o	x	x	o

Notes: Dependent variable is the number of matched cards in the individual card-matching game (columns 1 to 3) and in the group card-matching game (columns 4 to 6). Demographic controls include gender, number of siblings, birth order (first-born dummy), parents' age, parents' education, household monthly income, and religion. Further controls include raven test, academic achievement tests, and big-five personality traits. Individual performance is the baseline individual card-matching game result. All control variables were measured at the baseline survey which was conducted before the intervention. All regressions include a list of dummies for each class in each school (class fixed effects) and a list of dummies for each experimenter (experimenter fixed effects). For the group card-matching game performance (columns 3 to 6), a list of dummies for group size are further controlled. Standard errors are clustered at the level of full interactions among school, class, and survey time (52 clusters in total). Significance *** (1%), ** (5%), * (10%).