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MATHEMATICS CAMPS: A GIFT FOR GIFTED STUDENTS?

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Abstract

We evaluate a mathematics camp for gifted high-school students. During the camp, students work in teams, trying to solve advanced mathematics problems with the help of manipulatives. We randomize participation in the camp and test the effects of such participation on problem-solving skills, self-concept, and career intentions. Results show that participants improve their problem-solving skills, especially in questions that require the use of logic. We also find positive effects on students' self-concept. Students with a lower school math score benefit more from the program. Finally, participating in the mathematics camp makes students in first high school grade more willing to go to university.

JEL Classification: I21 ; I24 ; D04

Keywords: Randomized Control Trial; Mathematics; Extra-curricular Courses; Gifted Students; Talented Students

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1 Introduction

Gifted programs find their rationale in the public interest to promote individual self-fulfillment and in the positive returns in terms of economic and societal development (Renzulli [2012]). Since the late ’80s, several special education programs targeting gifted students have been introduced in the US.[1] These programs involve around 7% of the overall student population (Card and Giuliano [2014]). In Europe, many countries have introduced norms to match gifted students’ needs for special intervention starting in 2000. Still, research studies addressing the effectiveness of gifted programs focus on the US.[2] Most of the evaluated US programs are public schools programs, implemented at state or district level. This stands in contrast with gifted programs in Europe which are often short-lived, extra-curricular, and up to the initiative of teachers or private institutions. In this paper, we study the effects of a mathematics camp for gifted students in Italy on problem-solving skills, self-concept, and career intentions, using a randomized control trial.

The math camp is a long-lasting initiative promoted by Mathesis, an association of mathematics teachers, and it is financed by Compagnia di San Paolo, the second largest philanthropic organization in Italy. The camp takes place yearly at the end of the academic year (May-June) and lasts three days. It targets excellent students of high schools in Piedmont, a region in the North-West of Italy. Participants are in high school grades one to four (ages fourteen to eighteen). School mathematics teachers select the top two performing students in each class to attend the camp. During the camp, students are randomly assigned to teams of around six students and proposed advanced mathematics problems that are unrelated to the school curricula. These problems must be solved in collaboration with their teammates and each team must submit one solution that is then evaluated by the teachers. The team with the highest evaluation for each grade receives symbolic prizes at the end of the camp. Teachers facilitate mathematical reasoning by providing each team with math manipulatives. Hence, the camp is characterized by

[1] The US National Association for Gifted Students regrets the absence of a uniform federal policy for “gifted services”. See https://www.nagc.org/ for more detailed information.

[2] See Bhatt [2011], Bui, Craig, and Imberman [2014], Dougherty, Goodman, Hill, Schools, Litke, and Page [2014], Card and Giuliano [2014], and Murphy [2009].

peer-to-peer learning, “inquiry-based” activities, and a “hands-on” working style.

We evaluate the impact of participation in the math camp using a randomized control trial. Teachers typically choose a small number of students per class (the median is 2) according to a subjective criterion, which heavily relies on their school math grade but also takes into account students’ interest in mathematics and teacher-assessed potential. For our evaluation, we asked teachers to select one additional student per class, the first student teachers would have chosen if one of the two original students were not in the class. In other words, teachers select those students they would have selected in the absence of our evaluation and the first student on the “waiting list”. We then randomly selected one of the signaled students and exclude him/her from the math camp. The group of participants in the math camp constitutes our treatment group while excluded students are our control group. We then compare the answers of treated and control students in a questionnaire including demographic, psychological and career intentions questions, as well as mathematics problems. Additionally, we explore the heterogeneity of treatment effects by socio-demographic characteristics and by performance in math tests at school.

Which effects do we expect to find? The impact of mathematics courses on academic performance is positive in some contexts (Cortes, Goodman, and Nomi [2015] and Aughinbaugh [2012]) but negative in others (Clotfelter, Ladd, and Vigdor [2015]). These different results can be explained by differences in program characteristics. Previous literature indicates that effective mathematics programs are characterized by “inquiry-oriented” instruction (Blazar [2015]), frequent teacher feedback, the use of data to guide instruction, “high-dosage” tutoring, increased instructional time, and high expectations (Dobbie and Fryer Jr [2013]). Hence, we expect, that given its characteristics, our program positively affects mathematics problem-solving skills. Given the findings that self-esteem boosts performance (Ferkany [2008]), we are also interested in the impact of the math camp on self-concept. The effects of the camp on self-concept may be ambiguous as talented students surrounded by other talented students may update their beliefs about their position in the ability distribution upwards or downwards. For this reason, we test empirically the impact of participation in the camp on answers to the Big Five questionnaire, which captures five aspects of personality (i.e., Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) and a series of questions about students' opinion on what determines their academic success. Maestri [2013] finds that mathematics courses increase students' propensity to sign up for a mathematics degree. We test whether this finding also applies to our setup. Finally, the heterogeneous effects of math instruction found for students with different capacities (Cortes et al. [2015]) suggest that the effects of the camp may differ by student school performance.

We find that students participating in the mathematics camp improve their problem-solving skills. The improvement is higher in problems that require the use of logic rather than problems that require formal mathematics knowledge (formulas, standard solving methods, etc.). The estimated positive effect is heterogeneous and it is stronger for fourteen years old students, those with lower school mathematics grades, and those with high-educated parents. Regarding personality traits, the camp leads to improvements in self-concept: it reduces the incidence of neuroticism and fosters the perception of being talented. Students who particularly benefit from the math camp in psychological terms are fifteen years old and have low-educated fathers. Finally, only students in the earliest grade modify their career intentions after participation in the camp: fourteen years old students are more likely to declare that they will enroll in university and that they will choose a scientific degree.

The remainder of this paper is organized as follows. In Section 2 we present a review of the related literature. Section 3 provides details on the mathematics camp and the design of our randomized control trial. We describe our data and characterize our sample in Section 4. Section 5 shows that the groups of participants and excluded students are comparable and specifies the empirical strategy to estimate the effects of the camp. Section 6 establishes the main results on the impact of the mathematics camp. It also includes robustness checks and tests for heterogeneous treatment effects. Finally section 7 concludes.

1.1 Related Literature

Our paper relates to two strands of the literature: the estimation of the impact of studying mathematics on future outcomes and the analysis of the effectiveness of programs for gifted students. Regarding the former, a more rigorous high-school math curriculum is associated with a higher probability of attending college (Aughinbaugh [2012]). Their household fixed effect results imply that students who take an advanced academic math curriculum in high-school (algebra II or precalculus, trigonometry, or calculus) are about 17 % more likely to go to college compared to those students whose highest math class was algebra I or geometry. Studying maths also generates high labor market returns, especially in the early stages of working life, as a result of skill-biased technological changes (Deming and Noray [2018]).

Identifying the characteristics of mathematics programs that make them effective is essential for improving both theories of mathematical development and mathematics education. Blazar [2015] shows that inquiry-oriented instruction positively predicts student achievement. Content errors and imprecisions are negatively related to achievement. In the context of inquiry-oriented education programs, Dobbie and Fryer Jr [2013] shows that five characteristics: frequent feedback, use of data to guide instruction, high dosage tutoring, increased instructional time and high expectations about academic achievement explain about 45% of the variation in program effectiveness. Ellison and Swanson [2016] finds that the quality of school and teachers are particularly important for gifted students. Fuchs, Fuchs, Mathes, and Simmons [1997] shows that peer-to-peer learning increases mathematics achievement as measured by the Stanford Achievement Test (SAT).

We are also interested in how math programs affect future education decisions. According to Maestri [2013], extra-curricular activities for secondary school students in Chemistry, Physics, Math and Materials Science increase the probability of future enrollment in a scientific track by 3% for males, but do not affect females.

The second related strand of the literature focuses on the effects of gifted students' programs in the US. The results are mixed. Murphy [2009] and Bui et al. [2014] elicit the effect of gifted or talented services supplied to US students using a regression discontinuity approach comparing admitted students just above the minimum threshold for admittance with students not admitted but just below the threshold. Both studies find little or no impact on marginal students. Dougherty et al. [2014] use the same evaluation design in the context of the Wake County Public School System and find that accelerated math track for high performers has no significant effects on standardized test scores but lowers girls' grades in middle school. Targeted math acceleration has the potential to increase college readiness among disadvantaged populations only. In contrast, Bhatt [2011] finds significant improvements in math scores only, but her instrument does not pass the weak instrument test.

Gifted programs are evaluated not only in terms of their effectiveness to improve the outcomes of participants but also in terms of the suitability of their participant selection criteria. Card and Giuliano [2014] find that gifted programs implemented in the largest US school districts do not affect high IQ students. However, these programs have positive and relatively large effects on students with good school performance who would not normally qualify for gifted programs.

2 Background

The evaluated gifted mathematics program takes place in Italy. In general, Italian students perform poorly in mathematics according to PISA. In 2018, Italian 15-year-old students scored 487 points in mathematics tests, which is lower than the average of 489 points in OECD countries. The share of Italian top performers (students who attained levels 5 or 6 in PISA tests) is only 9.5 percent compared to 11.4 percent in the entire OECD. In this context, gifted programs may be useful to improve performance at the top of the Italian distribution.

Before 2007 Italian education authorities had paid limited attention to gifted students. Mönks, Pflüger, and Nijmegen [2005] elaborated a comprehensive review of education measures for gifted students across EU countries. In 2005 Italian talented children were then allowed to early school start (ISCED level 1), complete two grades in one year (ISCED levels 2 & 3), and take the final examinations in advance (ISCED level 3). Law

1/2007 and Decree 262/2007 first introduced the notion of fostering excellence in school in Italian legislation. In practice, they introduced a scholarship dedicated to top-achieving students. Only recently, in 2019, the Ministry for Education acknowledged gifted students' needs for special attention (l.562/2019). However, Italian authorities have not promoted concrete actions up to now.

In a context of low mathematics achievement and few institutional attention to gifted students, we evaluate the effectiveness of a mathematics program targeting gifted students. The Mathesis Mathematics Camp is an intensive three-days extra-curricular mathematics program that targets students from forty-five high-schools in Northwestern regions of Italy. Attendance is restricted to high performing students by invitation from their high school mathematics teachers. Selection criteria are discretionary but most teachers mainly rely on previous mathematics achievements. Other criteria include students' motivation and teacher-assessed potential.

The camp is organized by Associazione Subalpina Mathesis, a well-established association of high-school mathematics teachers. It has taken place yearly starting in 1995. The initiative is almost entirely financed by Fondazione Compagnia di San Paolo, the second largest philanthropic organization in Italy. Students' participation fee is about 90 euros and covers all expenses (including hotel accommodation, meals, and transportation to and from the camp). Schools pay the participation fee of low-income students.

Every year the camp takes place between late May and early June in Bardonecchia, a mountain site in the surroundings of Turin (the capital of Piedmont). About 1,500 students from the first to the fourth grades of high-school participate in each edition. Students in the last grade of high-school (the fifth grade) are excluded because they need to prepare university entry exams. The teaching staff is composed of approximately 120 high-school professors, 6 university professors, 8 graduate students, and 20 undergraduate students. Due to location capacity constraints, students are divided into 4 waves lasting three days each in which students of each grade are equally represented.

During the mathematics camp, students work in open spaces where each space is allocated to one grade. Students are assigned to teams of six components (exceptions of five and seven components are allowed when necessary) who work in separate tables.

Teachers circulate in between the tables to solve doubts about the wording of exercises and supervise activities.

In each edition, participants in the same grade work on a given mathematic topic by solving a series of related problems with the help of manipulatives provided by teachers. For instance, in 2019 first graders worked on algorithms, second graders devoted their time to the concept of infinite, third graders studied bar codes and cryptocurrencies while fourth-graders focused on non-Euclidean geometry. Teachers grade the proposed solution not only on the basis of its correctness but also on the originality of the problem-solving method. The team with the highest accumulated score is awarded a symbolic prize.

3 Randomized Experiment Design

Our study was conducted between November 2018 and June 2019. To carry out the evaluation we requested Mathesis to implement some changes to the ordinary organization. By January 2019 the high-school teachers involved in the program provided the list of participants. In a regular edition of the camp, each teacher would have chosen N_i students in each class i to participate in the camp. For the evaluation, teachers were asked to select $N_i + 1$ students. The extra student must be the one teachers would have chosen in the absence of one of the originally selected students. In order words, teachers need to add the first student in the waiting list. We would then randomly select one student per class to be excluded from participation in the camp. The set of excluded individuals forms our control group. We could have asked teachers to select only those students they would have selected in a regular year and exclude some of them but: (i) this would have changed the nature of the camp as there would be significantly fewer students participating, (ii) Mathesis teachers opposed this alternative as it would imply wasting resources. Alternatively, we could have extended the set of students signaled by teachers (for instance, we could have asked two additional students per class to have treatment and control groups of similar size) but, as explained to us by Mathesis teachers, this alternative would make our sample too different from the population of interest, i.e., gifted students. Following our rule, teachers selected 2,124 students to potentially participate in the camp.

In February 2019 teachers administered the pre-camp questionnaires to all the students in the list of potential participants. The test consists of seventy-four questions, divided into four sections: six student identification questions, fourteen socio-demographic questions, forty-five psychological and aptitude questions, nine mathematics-related questions including three problems and questions about the methods used to solve the three problems. We reproduce the pre-camp questionnaire in Appendix A.

By March 2019, based on the lists of candidates provided by the teachers, we randomly selected $\Sigma_{i=1}^{I} N_i$ from $\Sigma_{i=1}^{I} N_i + 1$ to attend the mathematics camp. We used stratified randomization by class, a process that guarantees that each class is represented in the final sample by the usual number of students. To foster collaboration in filling the post-camp questionnaires, we gave excluded students in first, second, and third grade the opportunity to participate in the camp in the following year. To fourth-grade students, we offered the opportunity to participate in a summer school at Collegio Carlo Alberto about mathematical applications to Economics, a research center associated with the University of Turin. After randomization, 1,479 students participated in the camp and 645 became part of the control group.

A week after the mathematics camp, teachers administered a post-camp questionnaire to students in treatment and control groups. The post-camp questionnaire consists of the six student identification questions, the fourteen socio-demographic questions in the pre-camp questionnaire, fifty psychological and aptitude questions (the forty-five questions in the pre-camp questionnaire and the Big Five), five mathematics problems and three questions about the methods used to solve the problems. We reproduce the post-camp questionnaire in Appendix 2.

4 Data and Descriptive Statistics

In the analysis we use information from two questionnaires: the pre-camp questionnaire administered in February 2019 and a post-camp questionnaire administered one week after the camp, in June 2019. We use students' answers to the pre-camp questionnaire to make sure that the groups of treated and control students are comparable ex-ante in terms of problem-solving skills and to minimize non-responses to the socio-demographic questions. We use the answers to the post-camp questionnaire to measure differences emerging between the two groups as a consequence of the camp.

In this section, we present descriptive statistics for the main individual characteristics, for the whole sample as well as treatment and the control groups, separately. In terms of socio-demographic characteristics, we focus on students' gender, year of birth, number of siblings, school scores in the first quarter (maths, Italian, and the average for all subjects), and parent's levels of education. The final sample is composed of students for whom we have information on the outcomes of interest and the socio-demographic controls. They are 1,346 students: 967 in the treatment group and 379 in the control group.

Table 1 reports the socio-demographic characteristics of all students involved in the randomized control trial, both treated and control. There are slightly more males (54%) than females. Students' years of birth are comprised between 2000 and 2005, corresponding to ages 14 to 19. The average student has only one sibling. There are slightly more students in first and second grades than in third and fourth grades. This happens because teachers associated with Mathesis are more represented in earlier grades. As teachers select the best math students to participate in the camp, their average math grade in the first quarter is high (8.3 out of 10). Their Italian grade is also relatively high but lower than the math grade (7.7 out of 10) and their average grade for all subjects is around 8. Regarding parental education, mothers with only compulsory education are around 7.5%, those with a high-school diploma around 44% and university graduated mothers are around 46%. The reference category is mothers with less than compulsory schooling. Fathers are less educated than mothers on average: 14% of fathers have only compulsory schooling, almost 42% of fathers are high school graduates, while 43% have attained university degrees. Again, the reference category are fathers with less than compulsory schooling.

Tables 2 and Table 3 summarize the socio-demographic characteristics of students in the treatment group (participants in the camp) and those in the control group (excluded from the camp), respectively. As a result of the randomization, those tables are very similar to the table of descriptive statistics for the whole sample. We explicitly test for differences in pre-existing characteristics between treated and control students in the next section.

Table 1: Demographics - Complete sample

Variable	Mean	Std. Dev.	Min.	Max.	N
Male	0.536	0.499	0	1	1346
Year of birth	2002.64	1.142	2000	2005	1299
N siblings	1.077	0.804	0	7	1346
Class==I	0.296	0.457	0	1	1346
Class==II	0.253	0.435	0	1	1346
Class==III	0.226	0.418	0	1	1346
Class==IV	0.225	0.418	0	1	1346
Math grade	8.295	0.998	5	10	1332
Italian grade	7.724	0.891	5	10	1329
Average grade	8.006	0.700	6	10	1328
Mother below high-school	0.075	0.264	0	1	1346
Mother high-school	0.444	0.497	0	1	1346
Mother university	0.464	0.499	0	1	1346
Father below high-school	0.139	0.346	0	1	1346
Father high-school	0.415	0.493	0	1	1346
Father university	0.434	0.496	0	1	1346

Note: Data is from the post-camp questionnaire complemented with data from the pre-camp questionnaire when missing.

Table 4 summarizes the answers to the five mathematics problems administered in the post-camp questionnaire. We show descriptive statistics for the complete sample, treatment and control groups, separately. The first three questions are standard mathematical problems: the first is a problem that can be solved through a system of equations, the second regards a second-order equation that can be represented using a parabola and the third is about geometry (in particular, a trapezoid). The last two questions do not require the use of mathematical concepts, they can be solved using logic. We include the latter to test how students react when they feel out of their "mathematics comfort zone". We call *Math score* the sum of correct answers to the five questions.

We designed the mathematics problems with the advice of Mathesis teachers in order to replicate the grade obtained by potential participants in the camp in school. The average Math score is 4.5 out of 5 which is equivalent to 9 out of 10 in the school score.

Table 2: Demographics - Treatment group

Variable	Mean	Std. Dev.	Min.	Max.	N
Male	0.534	0.499	0	1	967
Year of birth	2002.614	1.142	2000	2005	925
N siblings	1.071	0.783	0	5	967
Class==I	0.291	0.454	0	1	967
Class==II	0.249	0.433	0	1	967
Class==III	0.233	0.423	0	1	967
Class==IV	0.228	0.419	0	1	967
Math grade	8.291	1.01	5	10	954
talian grade	7.74	0.901	5	10	951
Average grade	8.022	0.712	6	9.6	951
Mother below high-school	0.077	0.266	0	1	967
Mother high-school	0.446	0.497	0	1	967
Mother university	0.465	0.499	0	1	967
Father below high-school	0.146	0.353	0	1	967
Father high-school	0.42	0.494	0	1	967
Father university	0.425	0.495	0	1	967

Note: Data is from the post-camp questionnaire complemented with data from the pre-camp questionnaire when missing.

This figure is slightly higher than the average school scores obtained in the first quarter (8.3). However, Mathesis teachers argue that first-quarter school scores are artificially low because some teachers lower those scores to motivate students. Teachers who adopt this practice compensate for this negative bias in the final scores at the end of the academic year. As reported by Mathesis, 9 is a reasonable average final grade for students in our sample. Participants to the camp answer correctly 0.2 more problems than excluded students, corresponding to an increase of 4% in the Math score. Treated students perform better than controls in all problems. The highest differences between treated and controls appear in the problems that require the use of logic. In the next section, we quantify these differences using regressions.

In Table 5 we describe students' Big Five personality traits that we use as additional dependent variables. Again, we show descriptive statistics for the entire sample, the treatment group, and the control group, separately. The Big Five model classifies personality traits into five categories: Openness, Conscientiousness, Extraversion, Agreeableness,

Table 3: Demographics - Control group

Variable	Mean	Std. Dev.	Min.	Max.	N
Male	0.541	0.499	0	1	379
Year of birth	2002.703	1.139	2000	2005	374
N siblings	1.09	0.856	0	7	379
Class==I	0.309	0.463	0	1	379
Class==II	0.264	0.441	0	1	379
Class==III	0.208	0.407	0	1	379
Class==IV	0.219	0.414	0	1	379
Math grade	8.305	0.97	5.5	10	378
Italian grade	7.684	0.865	6	10	378
Average grade	7.966	0.671	6	10	377
Mother below high- school	0.071	0.258	0	1	379
Mother high-school	0.441	0.497	0	1	379
Mother university	0.462	0.499	0	1	379
Father below high-school	0.121	0.327	0	1	379
Father high-school	0.404	0.491	0	1	379
Father university	0.456	0.499	0	1	379

Note: Data is from the post-camp questionnaire complemented with data from the pre-camp questionnaire when missing.

Neuroticism (Rothmann and Coetzer [2003]). The most prevalent personality trait among students in our sample is open-mindedness: the average score is 8.5 out of 10. After being open-minded, students decreasingly declare to be conscientious and responsible, friendly, extroverted and sociable, and finally neurotic. Students in the treatment group appear slightly friendlier, more extrovert, and less neurotic than students in the control group. We find no differences in open-mindedness or responsibility between treated and control students. We test whether these differences are statistically relevant using regressions in the next section.

5 Randomization and Econometric Strategy

We assign potential camp participants to treated and control groups using stratified randomization (Athey and Imbens [2017]). Each potential participant belongs to one stratum or class i. We denote the number of classes by I. Let N_i the number of participants in the

Table 4: Math statistics

Variable	Mean	Std. Dev.	Min.	Max.
Math score	4.561	0.738	1	5
Correct system of equations	0.969	0.174	0	1
Correct parabola	0.888	0.316	0	1
Correct trapezoid	0.956	0.205	0	1
Correct Logic I	0.849	0.358	0	1
Correct Logic II	0.899	0.301	0	1
Obs.		1346		
Treatment group:				
Math score	4.612	0.688	1	5
Correct system of equations	0.975	0.156	0	1
Correct parabola	0.9	0.301	0	1
Correct trapezoid	0.962	0.192	0	1
Correct Logic I	0.865	0.342	0	1
Correct Logic II	0.911	0.285	0	1
Obs.		967		
Control group:				
Math score	4.43	0.84	1	5
Correct system of equations	0.953	0.213	0	1
Correct parabola	0.858	0.35	0	1
Correct trapezoid	0.942	0.234	0	1
Correct Logic I	0.810	0.393	0	1
Correct Logic II	0.868	0.339	0	1
Obs.		379		

Note: Data is from the post-camp questionnaire.

camp who belong to class i. As teachers select one additional student per class, the number of units in stratum i, i.e. the number of potential participants in class i, is $N_i + 1$. We then randomly select one student in each stratum and exclude him/her from participation in the camp. As a result, the number of students in the treatment group is $N_T = \Sigma_{i=1}^{I} N_i$ and the number of excluded students equals the number of strata $N_C = \Sigma_{i=1}^{I} 1 = I$.

In Table 6 we test whether the randomization produced homogenous groups in terms of pre-determined characteristics. In particular, we test whether treated and control students have comparable socio-demographic characteristics and performance in the mathematics problems solved before the camp. The first column contains average values for treated students, the second column displays average values for controls, and the third column shows P-values for the null hypothesis that the difference between the values in columns 1 and 2 is zero. P-values show that there are no significant pre-camp differences

Table 5: Big Five Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Complete sample:				
Do you consider yourself friendly?	7.995	1.511	1	10
Do you consider yourself neurotic?	6.235	2.534	1	10
Do you consider yourself conscientious and responsible?	8.298	1.435	1	10
Do you consider yourself extrovert and sociable?	7.276	1.995	1	10
Do you consider yourself open-minded?	8.583	1.449	1	10
Obs.		1346		
Treatment group:				
Do you consider yourself friendly?	8.039	1.489	1	10
Do you consider yourself neurotic?	6.139	2.503	1	10
Do you consider yourself conscientious and responsible?	8.309	1.439	1	10
Do you consider yourself extrovert and sociable?	7.371	1.94	1	10
Do you consider yourself open-minded?	8.59	1.439	1	10
Obs.		967		
Control group:				
Do you consider yourself friendly?	7.881	1.563	1	10
Do you consider yourself neurotic?	6.48	2.599	1	10
Do you consider yourself conscientious and responsible?	8.272	1.426	1	10
Do you consider yourself extrovert and sociable?	7.034	2.112	1	10
Do you consider yourself open-minded?	8.565	1.476	3	10
Obs.		379		

Note: Data is from the post-camp questionnaire.

between the two groups.

Given that treated and control students were comparable ex-ante, we estimate the impact of participating in the camp on different outcomes using the following specification:

$$Y_i = \beta_1 T_i + \beta_2 \mathbf{X}_i + \delta_g + \epsilon_i \tag{1}$$

where Y_i is one of our outcome variables measuring student i's problem-solving skills, psychological traits, or career intentions. Regarding problem-solving skills, we study the number of correct answers (math score) and dummies for having solved each problem correctly, separately. The analyzed psychological traits include the Big Five personality traits and other measures of self-concept. Finally, the outcomes that measure career intentions comprise intentions to go to university, to study a STEM degree, or to study a maths degree. T_i is the dummy equal to 1 if student i were randomly assigned to the treatment

Table 6: Randomization Test

Variable	Mean treated	Mean control	p-value
Male	0.534	0.541	0.809
Year of Birth	2002.614	2002.703	0.202
N siblings	1.071	1.089	0.706
Class==I	0.290	0.308	0.512
Class==II	0.249	0.263	0.579
Class==III	0.233	0.208	0.339
Class==IV	0.227	0.219	0.737
Math grade	8.214	8.259	0.445
Italian grade	7.559	7.480	0.156
Average grade	7.945	7.930	0.636
Mother below high-school	0.076	0.077	0.741
Mother high-school	0.45	0.444	0.866
Mother university	0.461	0.452	0.905
Father below high-school	0.149	0.114	0.244
Father high-school	0.433	0.42	0.589
Father university	0.409	0.447	0.296
Pre-test			
Correct system of equations	0.969	0.971	0.848
Answered through logic	0.250	0.240	0.706
Answered through system of eq.	0.640	0.665	0.392
Answered through attempts	0.054	0.057	0.892
Correct parabola	0.872	0.839	0.117
Answered through formula	0.810	0.836	0.302
Answered through attempts	0.054	0.057	0.892
Correct rectangle	0.984	0.979	0.476
Answered through formula	0.335	0.314	0.459
Attempts drawing	0.133	0.108	0.210
Attempts without drawing	0.467	0.497	0.302

Note: Data is from the post-camp questionnaire complemented with data from the pre-camp questionnaire when missing.

group (i.e., participated in the camp) and 0 otherwise. $\mathbf{X}_i$ is a vector of control variables (gender, indicators for the number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Finally, ϵ_i is the error term.

6 Results

In this section, we discuss the results of estimating the impact of the math camp on mathematics problem-solving skills, self-concept, and academic career intentions as in Equation

1. Table 7 presents our estimates of the effect of the camp on problem-solving skills, measured by students' answers to the five mathematics problems proposed in the post-camp questionnaire. The outcome in Column 1 is the raw math score which is the number of correct answers given to the five problems. In column 2 we standardize the raw math score by grade so that standardized scores in each grade have average zero and standard deviation equal one. The standardized score takes into account that different grades have different raw test scores distributions because students in different grades differ in terms of age and time spent at school. Columns 3-7 display the results for each of the five mathematics problems, separately. The dependent variable in column 3 equals one if the student has solved correctly the proposed system of equations; in column 4 the outcome variable equals one for students who have identified correctly a second degree polynomial with the corresponding parabola; column 5 presents the impact of the camp on the probability of solving a geometry problem about a trapezoid; finally, columns 6 and 7 present our results for students' capacity to solve problems using logic (see Appendix 2 - Post-camp questionnaire - questions 7-15).

There is a significant positive effect of the math camp on mathematics problem-solving skills as measured both by the raw math score (0.139) and by the standardized math score (0.178). The estimated treatment effect ranges between 0.008 and 0.027 for the probability of solving the first three problems which can be solved using standard mathematics tools. The camp increases the probability of solving the two problems that require logic by 0.041 and 0.046, respectively. Hence, the camp improves performance in both traditional mathematics problems and in problems that benefit from brightness and perseverance but do not require specific mathematics knowledge (formulas, rules, etc.). However, the camp is much more effective for the latter.

In Table 8 we explore whether there are differences in the effect of the camp on problem-solving skills across students. In particular, we analyze whether the effectiveness of the camp differs by grade (from first to fourth grade), by gender, by math school score in the first quarter, and by parental education. In Column 1 we interact the treated dummy with dummies for each of the four grades; in Column 2 we include the interaction of treated and a male dummy; we multiply the treated dummy with the math school score in Col-

Table 7: Effect of the Treatment on Problem-Solving Abilities

	Math score	Std. score	Sys. of eq.	Parabola	Trapezio	Logic I	Logic II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treated	0.139	0.178	0.017	0.027	0.008	0.046	0.041
	(0.043)***	(0.059)***	(0.013)	(0.021)	(0.012)	(0.022)**	(0.019)**
Obs.	1346	1346	1346	1346	1346	1346	1346
R^2	0.035	0.034	0.01	0.022	0.013	0.027	0.016

Notes: Data is from the post-camp questionnaire. The dependent variables are the math score, the standardized math score, and dummies for having answered correctly each of the five mathematics problems. All regressions include a set of control variables (gender, grade, indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

umn 3; finally, in columns 4 and 5 we explore the heterogeneity of the treatment effect by maternal and paternal education, respectively.

In column 1, we find that treatment effects are statistically different from zero only for the first and fourth grades. The effect is highest for students in first grade (0.291) than in fourth grade (0.101). We cannot detect differences in camp effects by gender in column 2. The negative and significant coefficient of the interaction of the treated dummy and math school score in column 3 indicates that students with lower math grades benefit more from the camp. One extra point in the math school score reduces the impact of the camp by -0.083. Columns 4 and 5 show that the impact of the camp rises with parental education, both for mothers and fathers.

Table 9 presents our estimates for the impact of the camp on the Big Five personality traits. We only find a significant effect of the camp on neuroticism. The camp reduces the declared level of neuroticism by -0.351 on a 1 to 10 scale. The coefficients associated with the rest of personality traits (aggreeableness, conscientiousness, extraversion, and openness) are positive but not precisely estimated.

We explore the heterogeneity of the effect of the camp on neuroticism in Table 10. In column 1, we only find a significant negative effect for students in second grade. According to column 2, females are driving the negative effect of the camp on neuroticism. We could not find significant differences by math school scores in column 3. From column 4

Table 8: Heterogeneity in the Effect of the Treatment on Math Score

	Math Score				
	(1)	(2)	(3)	(4)	(5)
Treated		0.143 (0.066)**	0.825 (0.368)**		
Treated in grade I	0.291 (0.105)***				
Treated in grade II	0.078 (0.101)				
Treated in grade III	0.037 (0.065)				
Treated in grade IV	0.101 (0.06)*				
Treated by male		-.009 (0.086)			
Treated by math grade			-.083 (0.043)*		
Treated by mother<HS				0.13 (0.173)	
Treated by mother=HS				0.1 (0.059)*	
Treated by mother>HS				0.208 (0.07)***	
Treated by father<HS					-.003 (0.12)
Treated by father=HS					0.156 (0.069)**
Treated by father>HS					0.197 (0.065)***
Obs.	1346	1346	1346	1346	1346
R^2	0.04	0.035	0.038	0.039	0.039

Notes: Data is from the post-camp questionnaire. The dependent variable is the math score. All regressions include a set of control variables (gender, grade, indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

we learn that the negative impact of the camp on the level of neuroticism is strongest for children with low-medium educated parents.

Regarding the psychological sphere, we also asked students to declare the importance of three factors, namely effort, talent, and luck, in determining their academic achievement. In Table 11, we find a positive significant coefficient only for talent. Hence, partici-

Table 9: Effect of the Treatment on Self-Perception

	Agreeableness	Neuroticism	Conscientiousness	Extroversion	Openess
	(1)	(2)	(3)	(4)	(5)
Treatment	0.116	-.352	0.014	0.206	0.037
	(0.108)	(0.149)**	(0.084)	(0.138)	(0.104)
Obs.	1346	1346	1346	1346	1346
R^2	0.022	0.089	0.032	0.02	0.037

Notes: Data is from the post-camp questionnaire. The dependent variables are the Big Five personality traits. All regressions include a set of control variables (gender, grade, indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

pation in the mathematics camp makes students more likely to declare that their academic performance is the result of talent rather than effort or luck.

Finally, we analyze the impact of the camp on academic career intentions in Table 12. Unfortunately, columns 1 and 2 do not produce significant estimates of the impact of attending the mathematics camp on intentions to go to university or pursue a STEM degree. The math camp positively impacts intentions to go to university only for first-grade students: attending the camp increases the probability that those students declare their intention to enroll in university by 0.11. The absence of camp effects on higher grade students' intentions to go to university can be explained if intentions become less malleable as the actual decision to enroll in university approaches. Given the significant gender gap in STEM degree enrollment, we explore whether the camp is effective in fostering STEM degree enrollment for men or women. We do not find any gender difference in the impact of the camp on career intentions.

Table 10: Heterogeneity in the Effect of the Treatment on Neuroticism

	Neuroticism				
	(1)	(2)	(3)	(4)	(5)
Treatment		-.700	0.029		
		(0.217)***	(1.502)		
Treatment in grade I	-.278				
	(0.27)				
Treatment in grade II	-.724				
	(0.28)***				
Treatment in grade III	-.115				
	(0.387)				
Treatment in grade IV	-.271				
	(0.249)				
Treatment by male		0.677			
		(0.321)**			
Treatment by math grade			-.046		
			(0.178)		
Treatment by mother<HS				-.067	
				(0.529)	
Treatment by mother=HS				-.487	
				(0.243)**	
Treatment by mother>HS				-.209	
				(0.23)	
Treatment by father<HS					-.799
					(0.451)*
Treatment by father=HS					-.213
					(0.245)
Treatment by father>HS					-.322
					(0.261)
Obs.	1346	1346	1346	1346	1346
R^2	0.09	0.092	0.089	0.089	0.09

Notes: Data is from the post-camp questionnaire. The dependent variable is self-declared neuroticism. All regressions include a set of control variables (gender, grade, indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

Table 11: Effect of the Treatment on Determinants of School Performance

	Effort	Talent	Luck
	(1)	(2)	(3)
Treatment	0.189 (0.131)	0.287 (0.145)**	0.114 (0.154)
Obs.	1339	1339	1329
R^2	0.046	0.038	0.023

Notes: Data is from the post-camp questionnaire. The dependent variables capture to what extent students believe that their academic achievements are explained by effort, talent, and luck, respectively. All regressions include a set of control variables (gender, grade, indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

Table 12: Effect of the Treatment on Academic Intentions

	University	STEM	University	STEM	University	STEM
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.036 (0.029)	0.037 (0.028)			0.033 (0.036)	-.0009 (0.042)
Treatment in grade I			0.11 (0.055)**	0.018 (0.043)		
Treatment in grade II			-.012 (0.063)	-.031 (0.06)		
Treatment in grade III			-.012 (0.054)	0.071 (0.064)		
Treatment in grade IV			0.034 (0.038)	0.102 (0.063)		
Treatment by male					0.006 (0.056)	0.074 (0.061)
Obs.	1344	1341	1344	1341	1344	1341
R^2	0.036	0.034	0.039	0.037	0.036	0.035

Notes: Data is from the post-camp questionnaire. The dependent variables are intentions to go to university and to enroll on a STEM university degree. All regressions include a set of control variables (indicators for number of siblings, parental education dummies, math school score in the first quarter, and class fixed effects). Standard errors are clustered at class level.

7 Conclusions

In this paper, we use a randomized control trial to evaluate the impact of a gifted mathematics program on problem-solving skills, self-perception, and career intentions. The camp is representative of gifted programs in Europe because it constitutes a local, short, extra-curricular, and privately driven initiative. Its design is characterized by peer-to-peer learning, "inquiry-oriented" activities, and a "hands-on" learning style: students work in teams of approximately 6 students, trying to solve mathematics problems with the help of manipulatives.

In our randomized control trial, we asked teachers to select one additional student per class. This student must be the one teachers would have chosen if one of the original students were not in the class, i.e., the first student on the waiting list. We then randomly excluded one of the listed students in each class from participating in the math camp. We then estimated the impact of the math camp by comparing the answers of treated and control students on a questionnaire administered one week after the camp.

Our findings show that the math camp fosters students' problem-solving skills, especially for those problems that require the use of logic rather than mastering mathematics formulas or rules. Camp participants are in grades one to four of high-school (ages 14 to 18). The treatment is particularly effective for students in first grade, but also students in fourth grade significantly benefit from participating in the camp. We also find positive effects on students' self-concept in the short run. Students participating in the camp declare to be less neurotic and are more prone to consider that their talent (as opposed to luck or effort) explains their school performance. These short-run effects could vanish as the camp experience becomes more distant in the past or they may consolidate if students modify their behavior in standard math classes afterward. Testing this is an avenue for future research. Regarding career intentions, the camp fosters first-grade students' intentions to go to university. However, we could not find any effects of the camp on university degree choice.

We confirm the findings of previous studies that effective mathematics programs are characterized by "inquiry-oriented" instruction (Blazar [2015]), frequent teacher feedback, the use of data to guide instruction, “high-dosage” tutoring, increased instructional time, and high expectations (Dobbie and Fryer Jr [2013]).

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Appendices

A Pre-camp questionnaire

QUESTIONNAIRE FOR STUDENTS

Instructions

Dear Student,

we are carrying out a survey on the educational projects financed by the Compagnia di San Paolo and we need your help!

In the test you will find three math problems and a series of simple and quick questions we kindly ask you again to answer independently and sincerily. The compilation will take you no more than 45 minutes.

The test will consist of two parts.

- The first part must be completed in paper format, photographed or scanned and sent to the address: NDA
- The second part can be completed: online in the computer lab or or in paper format, photographed or scanned and sent to the email address: NDA

If for any reason the photo or the scan were not practicable, the questionnaires must be placed in cardboard boxes of transportable format. We sill pick them up immediately after the test. Remember that after filling the questionnaire you must click on the ”send” button that you find in the last page of the questionnaire.

Thank you very much for your collaboration!

http://youtube.com/watch?v=1WnmtWYRGag

Video containing detailed instructions.

BASIC INFORMATION

1. **Name**

. . . .

2. **Surname**

. . . .

3. **Class**

. . . .

4. **Section**

. . . .

5. **Type of school (scientific, grammar school, etc.)**

. . . .

6. **Name of school**

. . . .

MATHEMATICS QUESTIONS

Here are three math problems. In the time available, 25 minutes:

– put your phone aside and get a sheet of paper,

– start each page with your first and last name, section and school,

– for each problem, specify the steps that led you to the solution.

When you're done, take a picture and send it to mathesis@carloalberto.org. In the subject you specify your name and surname, class, section and school.

7. **Did you send the email with your exercises by email?**

   ☐ Yes

   ☐ No

8. **Problem 1**

In an ice cream shop, Anna and Martina order a cup and a granita and pay 5 euros. In another table Pietro, Mario and Emilio order a cup and two granitas and pay 7 euros. How much does a cup cost? How much does a granita cost?

- ☐ I didn’t find a solution
- ☐ I found a solution

9. The price of a cup is...........

10. The price of a granita is.............

11. **I arrived at the solution in the following way:**

    - ☐ System of equations
    - ☐ Using deduction
    - ☐ Trying alternatives
    - ☐ Other:

12. **Problem 2**

    In one exam a student found the following equation which represents a parabola:

    $$y - 5 = 4(x + 3)^2 \tag{2}$$

    For the same parabola another student finds:

    $$y = 4x^2 + 24x + 31 \tag{3}$$

    Can they both be right?

    - ☐ Yes
    - ☐ No
    - ☐ I don’t know

13. **I arrived at the solution in the following way:**

- □ Using the formula
- □ Trying alternative values of x and y
- □ Drawing the parabola
- □ Other:

14. **Problem 3**

Consider a rectangle of size 6*4, what can be the size of a rectangle with exactly half of its area?

- □ I didn't find a solution
- □ I found the right solution (area 20 cm^2)
- □ I found the wrong solution (area different from 20 cm^2)
- □ Other:

15. **I arrived at the solution in the following way:**

- □ I found one example by drawing
- □ I found more than one example by drawing
- □ I found one example without drawing
- □ I found more than one example without drawing
- □ I wrote the formula for the generic case
- □ Other:

SOCIO-DEMOGRAPHIC QUESTIONS

Thank you for your answers! Now we ask you to answer to a few socio-demograohic and attitudinal questions. Remember to answer 0 if you don't agree at all with the statement of the question and the maximum value if you fully agree with the statement.

16. **Write your date of birth**

. . . .

17. **Are you male or female?**

 □ M
 □ F
 □ I don't want to answer

18. **Which is the ZIP Code (CAP) of your home?**

. . . .

19. **Indicate your mother's level of education**

 □ Graduate or Post-graduate
 □ High-School
 □ Compulsory school
 □ Nothing

20. **Indicate your father's level of education**

- ☐ Graduate or Post-graduate
- ☐ High-School
- ☐ Compulsory school
- ☐ Nothing

21. **How many brothers/sisters do you have?**

. . . .

22. **Are your brothers/sisters younger or older than you?**

Brother/sister 1

- ☐ Older
- ☐ Younger

Brother/sister 2

- ☐ Older
- ☐ Younger

Brother/sister 3

- ☐ Older

- ☐ Younger

Brother/sister 4

- ☐ Older
- ☐ Younger

23. **After high school, are you going to enroll at university?**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

24. **If yes, are you are going to enroll in a STEM major?**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

25. **If yes, are you are going to enroll in a Math major?**

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5

26. **Which was your Math grade in the current semester?**

    . . . .

27. **Which was your Italian grade in the current semester?**

    . . . .

28. **Which was your average grade in the current semester?**

    . . . .

29. **Write name and surname of your math teacher**

    . . . .

PSYCHOLOGICAL AND APTITUDE QUESTIONS

Your school performance is the result of:

30. Indicate on a 0-10 scale the weight of each component on your school performance. Remember that the sum must be 10.

    Effort

    . . . .

    Talent

    . . . .

    Luck

    . . . .

31. **Who do you do your homework / studies with? (more than one answer is possible)**

    - ☐ Alone, without supervision or help
    - ☐ Together with friends and companions
    - ☐ An adult helps me
    - ☐ An adult supervises me and checks my homework
    - ☐ Other:

32. **If you are around 100 people who are your age, how many do you usually consider more intelligent than you?**

    . . . .

33. **If you are around 100 people who are your age, how many do you usually consider better than you in math?**

. . . .

34. **If you can't solve a mathematical problem that the professor gave you as a task (more than one answer possible):**

    - □ You forget about it and the next day you tell the professor that you couldn't solve it
    - □ You ask an adult for help
    - □ You ask a mate for help
    - □ You consult books
    - □ Other:

35. **If you find it difficult to solve a mathematical problem, for how many minutes you try before adopting one of the solutions mentioned earlier?**

. . . .

Now we ask you to instinctively report how much you agree with the following statements (from 1 to 5):

36. **I get discouraged easily**

. . . .

37. **I don't speak in the presence of strangers**

. . . .

38. **I make new friends easily**

. . . .

39. **I find alternative solutions to problems**

. . . .

40. **I like working with other people**

. . . .

41. **When I work with other people I listen to their ideas**

. . . .

42. **I know when it's appropriate to talk about my personal problems to others**

. . . .

43. **When I encounter obstacles, I remember the situations in which I encountered similar obstacles in the past and I managed to overcome them**

. . . .

44. **I expect to do well in most of the things I do**

. . . .

45. **People trust in me easily**

. . . .

46. **I struggle to understand the non-verbal messages of others**

. . . .

47. **Some important episodes of my life have led me to rethink what is important and what is not**

. . . .

48. **When my mood changes, I see new possibilities**

. . . .

49. **Emotions are among the things that make life worth living**

. . . .

50. **I am aware of my emotions**

. . . .

51. **I have an optimistic attitude**

. . . .

52. **I like to share my emotions with other people**

. . . .

53. **When I experience a positive emotion, I know how to make it last**

. . . .

54. **I organize events that others like**

. . . .

55. **I try to do things that make me happy**

. . . .

56. **I am aware of the non-verbal messages I send to others**

. . . .

57. **I make a good first impression on others**

. . . .

58. **When I'm in a good mood, it's easy to solve problems**

. . . .

59. **Based on the facial expression, I can recognize the emotions felt by others**

. . . .

60. **I know why my emotions change**

. . . .

61. **When I am happy it is easier for me to have good ideas**

. . . .

62. **I am able to control my emotions**

. . . .

63. **I am able to identify my emotions easily**

. . . .

64. **I find motivation by imagining positive results for the tasks I face**

. . . .

65. **I congratulate others when they do something well**

. . . .

66. **I am aware of the non-verbal messages that people send**

. . . .

67. **When someone tells me about an important event in his or her life, it almost seems to me I have personally experienced it**

. . . .

68. **When I feel an emotional change, I tend to produce new ideas**

. . . .

69. **When I face a challenge, I give up, thinking I won't make it**

. . . .

70. **I just need to look at people to see how they feel**

. . . .

71. **I help people feel better when they are feeling a little down**

. . . .

72. **I use my sense of humor to face obstacles**

. . . .

73. **I understand how people feel by listening to their tone of voice**

. . . .

74. **I find it hard to understand why people feel a certain way**

. . . .

Information for scientific research (articles 13 and 14 of the EU Reg 2016/679)

The test is finished, thanks for your help! Remember to click ″submit / submit″ before closing this page

2 Post-camp questionnaire

QUESTIONNAIRE FOR STUDENTS

Instructions

Dear Student,

our evaluation of the mathematics camp of the Mathesis Association is coming to an end and we need your help for the last time!

In the test you will find five math problems and a series of simple and quick questions we kindly ask you again to answer independently and sincerily. The compilation will take you no more than 50 minutes.
The test will consist of two parts.

- The first part must be completed in paper format, photographed or scanned and sent to the address: NDA

- The second part can be completed: online in the computer lab or or in paper format, photographed or scanned and sent to the email address: NDA

If for any reason the photo or the scan were not practicable, the questionnaires must be placed in cardboard boxes of transportable format. We sill pick them up immediately after the test. Remember that after filling the questionnaire you must click on the "send" button that you find in the last page of the questionnaire.
Thank you very much for your collaboration!

BASIC INFORMATION

See Appendix A, related section.

MATHEMATICS QUESTIONS

Here are five math problems. In the time available, 35 minutes:

- put your phone aside and get a sheet of paper,
- start each page with your first and last name, section and school,
- for each problem, specify the steps that led you to the solution.

When you're done, take a picture and send it to mathesis2@carloalberto.org. In the subject you specify your name and surname, class, section and school.

1. **Did you send the email with your exercises by email?**

   ☐ Yes

   ☐ No

2. **Problem 1**

   The age of the father is 15 years higher than the age of the child. Knowing that the sum of the age of the father and child is 57 years, the age of the child is:

   ☐ 12

   ☐ 13

   ☐ 14

   ☐ 16

   ☐ Other:

3. **I arrived at the solution in the following way:**

   □ System of equations

   □ Using deduction

   □ Trying alternatives

   □ Other:

4. **Problem 2**

   In one exam a student found the following equation which represents a parabola:

   $$y - 6 = \frac{1}{2}(x - 2)^2 \tag{4}$$

   For the same parabola another student finds:

   $$y = \frac{1}{2}x^2 - 2x + 8 \tag{5}$$

   Can they both be right?

   □ Yes

   □ No

   □ I don't know

5. **I arrived at the solution in the following way:**

   □ Using the formula

   □ Trying alternative values of x and y

   □ Drawing the parabola

- ☐ Other:

6. **Problem 3**

   Consider an isosceles trapezoid with a base of 7 cm, a minor base 3 cm and a height of 4 cm. What can be the size of a rectangle with exactly its area?

   - ☐ I didn't find a solution
   - ☐ I found the right solution (area 20 cm^2)
   - ☐ I found the wrong solution (area different from 20 cm^2)
   - ☐ Other:

7. **I arrived at the solution in the following way:**

   - ☐ I found one example by drawing
   - ☐ I found more than one example by drawing
   - ☐ I found one example without drawing
   - ☐ I found more than one example without drawing
   - ☐ I wrote the formula for the generic case
   - ☐ Other:

8. **Problem 4**

   There were five parrots in a cage. Their average price was 60 euros. One day the most beautiful flies away. The average price of the remaining is 50 euros. What was the price of the one who ran away?

   ....

9. **Problem 5**

In the same month, three Sundays fell on even days. What day of the week was the 20th of that month?

. . . .

SOCIO-DEMOGRAPHIC QUESTIONS

See Appendix A, related section.

PSYCHOLOGICAL AND APTITUTE QUESTIONS

See Appendix A, related section.

BIG FIVE QUESTIONS (scale 0-10)

10. **Do you consider yourself an extrovert and sociable person?**

. . . .

11. **Do you consider yourself a friendly person?**

. . . .

12. **Do you consider yourself a sociable and conscientious person?**

. . . .

13. **Do you consider yourself a neurotic person?**

. . . .

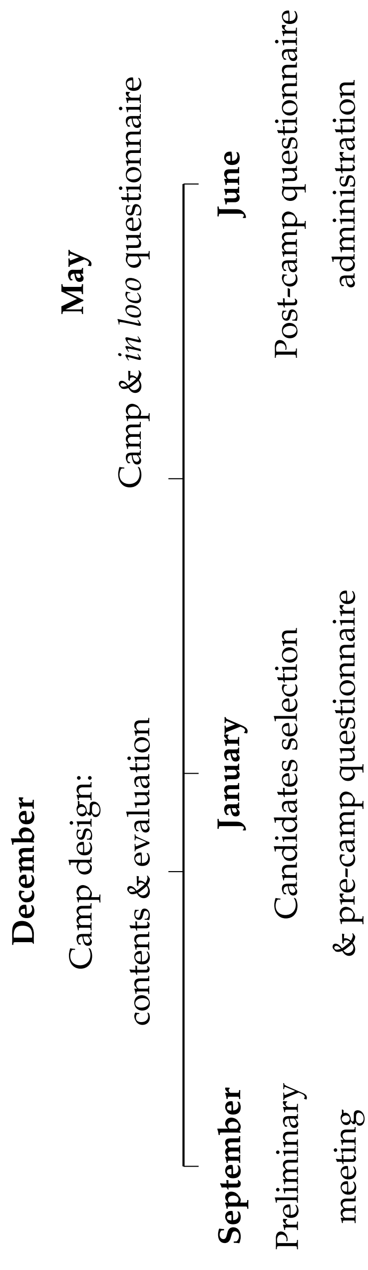
14. **Do you consider yourself an open-minded person?**

. . . .

Information for scientific research (articles 13 and 14 of the EU Reg 2016/679)

The test is finished, thanks for your help! Remember to click ”submit / submit” before closing this page

3 Timing of the Study



4 Full set of results for the main regression

Table 13 is the extended version of Table 7. It displays the coefficients associated to the controls.

Table 13: Effect of the Treatment on Problem-Solving Abilities

	Math score	Std. score	Sys. of eq.	Parabola	Trapezio	Logic I	Logic II
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treated	0.139 (0.043)***	0.178 (0.059)***	0.017 (0.013)	0.027 (0.021)	0.008 (0.012)	0.046 (0.022)**	0.041 (0.019)**
Male	0.058 (0.046)	0.066 (0.063)	-.005 (0.009)	0.018 (0.019)	0.006 (0.018)	0.06 (0.025)**	-.020 (0.019)
One sibling	0.06 (0.052)	0.104 (0.074)	-.006 (0.011)	-.028 (0.025)	0.025 (0.014)*	0.054 (0.028)**	0.015 (0.026)
Two siblings	-.032 (0.072)	-.044 (0.109)	-.011 (0.015)	-.034 (0.026)	0.015 (0.019)	0.033 (0.034)	-.035 (0.033)
Three siblings	0.122 (0.172)	0.126 (0.248)	0.007 (0.011)	-.045 (0.084)	0.022 (0.04)	0.066 (0.076)	0.072 (0.068)
Four siblings	0.242 (0.281)	0.465 (0.417)	-.0004 (0.125)	0.249 (0.14)*	0.084 (0.055)	-.024 (0.132)	-.067 (0.166)
Five siblings	-.391 (0.312)	-.404 (0.357)	0.049 (0.039)	-.281 (0.247)	0.067 (0.051)	0.06 (0.066)	-.287 (0.209)
Six siblings	0.105 (0.07)	0.154 (0.098)	0.005 (0.018)	-.026 (0.038)	0.015 (0.021)	0.068 (0.038)*	0.043 (0.032)
Seven siblings	0.409 (0.068)***	0.688 (0.088)***	0.034 (0.017)**	0.029 (0.034)	0.088 (0.021)***	0.19 (0.035)***	0.068 (0.029)**
Father high-school	-.063 (0.066)	-.068 (0.095)	0.016 (0.017)	-.030 (0.026)	-.024 (0.021)	-.025 (0.03)	0.001 (0.027)
Father university	0.048 (0.072)	0.095 (0.104)	0.027 (0.02)	0.011 (0.027)	-.004 (0.02)	0.003 (0.034)	0.011 (0.03)
Mother high-school	-.026 (0.068)	-.010 (0.103)	-.007 (0.021)	-.013 (0.032)	0.01 (0.024)	0.008 (0.028)	-.024 (0.031)
Mother university	-.020 (0.069)	-.021 (0.104)	-.032 (0.026)	-.021 (0.034)	-.002 (0.026)	0.033 (0.031)	0.002 (0.032)
Math school score	0.094 (0.022)***	0.127 (0.029)***	0.006 (0.004)	0.025 (0.009)***	0.018 (0.008)**	0.032 (0.012)***	0.012 (0.009)
Obs.	1,346	1,346	1,346	1,346	1,346	1,346	1,346
R^2	0.035	0.034	0.01	0.022	0.013	0.027	0.016

Notes: Data is from the post-camp questionnaire. Standard errors are clustered at class level.

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