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The Covid-19 pandemic and school closure: learning loss in mathematics in primary education [*]

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Abstract

Italy was the first Western country hit by Covid-19 in February 2020, responding with a tight lockdown and full school closure until the end of the school year. This paper estimates the effect of the pandemic and school closure on the math skills of primary school pupils in Italy. We compare the learning achievements of two cohorts of pupils, the pre-Covid and the Covid cohort. For both cohorts, we match scores on the national standardised assessment in grade 2 with scores on a standardised test delivered by the researchers at the end of grade 3. The pandemic had a large negative impact on the pupils' performance in mathematics (-0.19 standard deviations). Among children of low-educated parents, the learning loss was larger for the best-performing ones (up to -0.51 s.d.) and for girls (-0.29 s.d.).

JEL codes: I21, I24

Keywords: COVID-19; school closure; learning loss; mathematics; standardised tests; inequality; primary school

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1. Introduction

In a bid to contain the number of cases during the Covid-19 pandemic, most countries imposed severe lockdown measures. Schools worldwide were closed for several months starting from spring 2020. By the end of June 2020, students had experienced 7 to 19 weeks of school closure and UNESCO (2020) reported that about 1.6 billion students, more than 90% of the world's student population, did not attend in-person teaching. A year later, by the end of June 2021, the weeks of closure had risen to 60. In most countries, school closures were just one of the features of the lockdown, which also included severe measures to ensure social distance and limited contact with others. Many children's lives were also profoundly affected by the pandemic in other ways, such as in the case of parental job loss or friends' and relatives' illnesses.

These disruptions have raised concern over the human capital development of children, both in the short- and the long-term (OECD 2021), related to learning losses, adverse socio-emotional effects, mental health issues, and increasing educational inequalities. In 2020, for the first time since the concept was developed, the United Nations Development Programme simulated a decrease in human development of about -0.025 (UNDP 2020).

The detrimental effect of Covid-19 school closures on the educational performance of primary school pupils and educational inequality has been empirically assessed in a number of studies analysing standardised test scores, mainly focused on Anglo-Saxon countries and a few Western European countries (Belgium, Germany, and the Netherlands).[1] The majority of these studies report declining student achievements both in reading/comprehension and in math, with about 0.07-0.10 standard deviations in the latter for 8-10 weeks of school closure. The notable exception is Maldonado and De Witte (2021), who quantify the learning loss in Belgium to be about 0.19 standard deviations in math and 0.29 in Dutch for 9 weeks of school closure. The research also documents larger learning losses for disadvantaged children and children living in deprived areas or enrolled in low socioeconomic (SES) schools.

In this paper, we evaluate the impact of the pandemic and school closures during the spring of 2020 on the mathematics achievements of primary school pupils in Italy, in the province of Torino. We compare the progress over about one year of two cohorts: a pre-Covid cohort – pupils enrolled in grade 3 during the school year 2018-19 – and a Covid cohort – pupils enrolled in grade 3 during the school year 2019-20 who experienced school closure and the pandemic. For both cohorts, we use scores from the national standardised assessment in grade 2, matched with the scores from a standardised test delivered by the researchers at the end of grade 3. Our main goal

[1] *Australia*: Gore et al. 2021. *U.S. states*: Dorn et al. 2020, Kuhfeld et al. 2020, Domingue et al. 2021, Kogan and Lavertu 2021, Pier et al. 2021. *United Kingdom*: Blainey and Hannay 2021, Renaissance Learning 2021, Rose et al. 2021. *Belgium*: Maldonado and De Witte 2021. *Netherlands*: Engezell et al. 2021, Haelermans et al. 2021; *Germany*: Schult et al. 2021. *Switzerland*: Tomasik et al. 2020.

is to estimate the impact of the school closure on learning inequalities. To this aim, we focus on the heterogeneous impact of the pandemic by family background and prior level of achievement.

The effects of the school closure across countries are likely to be strongly influenced by the school system and the characteristics of the pandemic itself, such as the infection rate, the type of lockdown, and the length of school closure. To the best of our knowledge, this is the first paper looking at the impact of the pandemic on Italian children's learning, adding to preliminary descriptive evidence available from the national assessment conducted in 2021 (INVALSI 2021).[2]

Italy is a particularly interesting case, because it was one of the first countries severely affected by the Covid-19 pandemic after China, and the first Western country to experience a widespread outbreak and rapid transmission of the virus. Italian schools were closed for almost an entire semester, for 15 weeks starting on February 24, 2020. This was one of the longest school closures in Europe during spring 2020, where the average school closure lasted less than 10 weeks. In-person instruction was replaced, whenever possible, by distance education, with teachers, pupils, and schools alike largely unprepared and left struggling to cope. Apart from school closures, the first Italian lockdown entailed the enforcement of strict social distancing measures. Public parks were closed, and people were only permitted to walk within a radius of 200 meters from home. All social venues, such as coffee shops, restaurants, museums, and libraries, as well as most business and service activities were closed, with the exception of "essential" ones. This had serious repercussions on income and employment. The staggering number of infections, which was largely underestimated in 2020, put enormous pressure on the health care system, and completely upended the lives of families and children. Champeaux et al. (2020) found that the negative effect of the lockdown on children's emotional wellbeing, estimated on the basis of parents' perception, was twice as large for Italian children than for French ones. However, due to the lack of national assessments in 2020, there is no documented evidence of the effect of the pandemic on learning losses in Italy.

It should be noted that before the outbreak of the pandemic, Italy had one of the lowest scores on the Digital Economy and Society Index in the European Union, one of the lowest shares of households with a fixed broadband subscription, and one of the lowest shares of individuals with at least basic software skills (European Commission 2020). These figures are mirrored within school settings, with teachers usually having low ICT skills and little experience with blended and technology-enhanced teaching (OECD 2018, European Schoolnet 2012).

[2] INVALSI measured children's skills in math and Italian in May 2021 and compared them with the previous assessment from May 2019. They found that learning losses in primary school were negligible in Italian and small in math (INVALSI 2021). However, their results are based on a raw difference between the two cohorts (i.e. second grade in 2019 and 2021) and cannot be interpreted in a causal way, without controlling for prior performance and possible compositional differences.

Engzell et al. (2021) has defined the Netherlands as a "best-case" scenario, because of its short school closures, the low impact of the first wave of the pandemic, the country's high degree of technological preparedness, and more in general, its well organised and efficiently managed school system (Woessmann 2016). Under the same criteria, Italy might instead be considered one of the "worst-case" pandemic scenarios in Europe.

There are at least two main reasons for evaluating the impact of the pandemic on primary school children in Italy. The first and more general one is that childhood is a crucial period for the development of an individual over the entire lifecycle, and child development is considered a dynamic and cumulative process, where early investments have the highest rate of return. Also, inequalities in children's cognitive skills and academic achievements due to family background arise early in life and increase quickly over time (Cunha and Heckman 2008). Second, during the 2020 lockdown, only 65% of primary school pupils in Italy were provided opportunities for online lessons, as opposed to almost 100% of lower and upper secondary school students (Champeaux et al. 2020).

Our results indicate that the school closure had a large negative mean impact on the math competencies of pupils (-0.19 standard deviations), which is equivalent to about 3 months of school. Somewhat unexpectedly, on average we do not find evidence of increasing inequalities among children with different family backgrounds. Instead, we find heterogeneous patterns within the group of children with low-educated parents: the learning loss in that cohort was larger for the best-performing children (up to -0.51 s.d.) and for girls (-0.29 s.d.).

Our results suggest that the children whose performance suffered most were those who normally benefit the most from attending school. The children of low-educated parents may have had little support within the family to cope with the situation, and among them, the best-performing were those who usually gain most from school attendance.

The rest of the paper is organised as follows. Section 2 summarises the possible channels through which the pandemic may have affected learning and the existing evidence. Section 3 presents the empirical strategy and Section 4 describes the data. In Section 5, we report our main results on the effects of the pandemic on math skills and the effects in terms of educational inequality. Section 6 discusses the limitations of the study, and Section 7 concludes.

2. Background

The effects of the pandemic on pupils' educational outcomes could be direct, as a result of school closures, or indirect, as the result of changes in the lives of the children and their families which may, in turn, have had an impact on learning.

Direct effects. Following the analysis by Agostinelli et al. (2020), we expect school closure to have a detrimental effect on pupils' educational outcomes and to widen educational inequalities owing to the different effects it had on children's development across the socioeconomic ladder.

First, the crisis was characterised by the widespread use of distance learning, but the digital tools and stable internet connection required for taking part in online lessons were not always available to children. As many as 12.3% of students in Italy between 6 and 17 years did not have access to a computer or other digital tools at home in the years 2018-19 (Istat 2020). Students lacking a computer/tablet or a good internet connection may have been severely affected by the school closure (Gavosto and Romano 2020). Moreover, global evidence shows that online learning is not as effective as the traditional classroom (Andrew et al. 2020). A starting point for evaluating the direct impact of the shift to distance learning is that of the existing research on the effect of time-in-school and summer learning loss. There is evidence that time spent in school reduces inequalities, particularly in math (Battistin and Meroni 2016, Marcotte 2007), and that long summer breaks have negative effects on educational outcomes and are a major source of learning inequality (Alexander et al. 2007, Cooper et al. 1996, Downey et al. 2004).

The second channel pointed out by Agostinelli et al. (2020) is the change in peer environment. In our scenario, the peer effect involves the psychological impact of losing contact with some friends and having a different pool of peers to socialise with. In turn, socialisation with peers has a sizeable impact on education (Epple and Romano 2011, Sacerdote 2011), and may negatively impact children's academic performance. This effect is particularly large for low-attaining children and children from disadvantaged families, for whom schools provide an opportunity to socialise with children from more privileged households. Thus, another way that Covid-19 school closures increased educational inequality was through changes in the peer groups that children had access to. One of the channels through which schools operate as an equalizer is by mixing children from different socioeconomic backgrounds.

The third channel was the parents' response to the school closure (Agostinelli et al. 2020). Distance learning places additional demands on parents, whose response depends on their level of education, time availability and financial resources: richer and better-educated parents are in a better position to meet these demands. In response to the closing of schools, those parents may have invested more in their children than poor parents, since not only did they have more financial resources to do so and higher levels of previous knowledge, but their children had on average higher human capital. Hence, parents' response to school closure added another layer of inequality to educational opportunities.

Indirect effect. Besides the direct effect of school closure on children's learning, the pandemic impacted pupils' educational outcomes by affecting several other aspects of their lives. The pandemic may have caused children to face severe changes such as parental job loss, disruptions in social ties, a lack of after-school activities, crowded dwellings, illness, and death of relatives due to Covid, isolation, and stress. Each of these changes could have affected children's learning: students whose parents experienced partial or complete earning loss would have been less likely to receive additional paid learning resources (Hupkau et al. 2020) and more likely to experience grade retention (Stevens and Schaller 2011) than similar children whose parents did not experience a drop in earnings; paternal job loss has been found to have a negative effect on children's school performance (Rege et al. 2011, Ruiz-Valenzuela 2020); after-school activities like sports, school-related activities, reading and caring/tidying up activities have been estimated to have a positive effect on children's cognitive and non-cognitive development (Fiorini and Keane 2014, Felfe et al. 2016, Meroni et al. 2021), which in turn may influence learning abilities and cognitive development (Almlund et al. 2011); finally, for all the reasons mentioned above, the quarantine has been reported to have negatively affected children's mental wellbeing, and particularly their ability to concentrate (Orgilés et al. 2020), which was made even more difficult by crowded dwellings. These changes also seem to have had an unequal effect on children's educational outcomes, especially through the higher probability of parents from disadvantaged backgrounds to have experienced a partial or complete earnings loss since the onset of the pandemic (Hupkau et al. 2020) and the larger impact of parental job loss on educational outcome for disadvantaged students (Rege et al. 2011, Ruiz-Valenzuela 2020).

3. Empirical strategy

To evaluate the effects of the Covid-19 pandemic on the math achievements of children, we adopt a difference-in-differences strategy. In our sample, there are two cohorts of children. The treated children are those who at the end of grade 3 had experienced the pandemic and school closure (for the sake of brevity, we refer to them as the "Covid cohort"). The Covid cohort were enrolled in grade 3 during the school year 2019-2020 and were provided with distance learning instead of in-person classroom lessons from February 2020 until the end of the school year. The control children were those enrolled in grade 3 during the school year 2018-2019 who participated solely in traditional classroom lessons (the pre-Covid cohort).

Due to the availability of longitudinal data at the individual level (see Section 4), we can estimate the average impact of the Covid-19 pandemic on math achievements with the following model:

$$Y_{1ikj} = \beta_0 + \beta_1 C_{kj} + \beta_2 Y_{0ikj} + \beta_3 X_{ikj} + \beta_4 D_j + e_{ikj} \quad (1)$$

where Y_{1ikj} is a standardized math test set by child *i* of cohort *k* in school *j* at about age 8, i.e. at the end of grade 3 (MATHGAP test, described below); C_{kj} is a dummy variable equal to 1 if the child i is in the Covid cohort k, 0 otherwise; Y_{0ikj} is a vector of initial skills at about age 7, including the standardized math and Italian tests taken at the end of grade 2 (INVALSI tests, described below) and the mark in math assigned by the teachers at the end of the first term of grade 2; X_{ikj} is a vector of sociodemographic variables (age, gender, migratory background, parental education);[3] D_j is a vector of school dummies, i.e. school fixed effects, which account for the large heterogeneity observed across schools; e_{ikj} are stochastic errors normally distributed and clustered at the class level. β_1 is the coefficient of interest: it captures the causal effect of being part of the Covid cohort rather than the pre-Covid cohort on math skills at age 8, given previous performance in math and Italian. As the outcome variable is standardised, the impact is expressed in terms of standard deviations. The identifying assumption is that conditional on grade 2 test abilities, the math performance of children in grade 3 in the Covid cohort would have been the same as the pre-Covid cohort had the pandemic not occurred. This assumption seems rather weak, given that the two cohorts are just one year apart.

Since we are not only interested in the average impact of the pandemic but also in its differential impact across children with different socio-demographic characteristics, we also estimate a similar model including a set of interactions between C_{kj} (the dummy identifying the Covid-cohort) and initial math competences, gender, migratory background, and parental education. To highlight potential differences between social backgrounds, we also estimate the coefficients of such interactions separately for the children with low- and high-educated parents.

It is necessary here to clarify an important point about the outcome variable. Y_{1ikj} was observed at the end of grade 3 (at the end of April 2019) for children in the pre-Covid cohort, but at the beginning of grade 4 (October 2020) for children in the Covid cohort (because of the Covid-related school closure in the spring of 2020). The potential consequences of this temporal misalignment will be discussed in Section 6.

4. Data and descriptive statistics

4.1 Data and math tests

We construct a unique dataset, linking the results of a standardised test administered by the research team to pupils at the end of grade 3 (named the MATHGAP test) with information coming from the Italian National Institute for the Evaluation of Education and Training System (INVALSI), which includes the INVALSI standardised tests in math and Italian administered at the end of grade 2, teacher-assigned marks, and socio-demographic variables.

[3] A definition of dependent and independent variables can be found in Table A1 in Appendix A.

INVALSI assessments in grade 2

In the Italian educational system, children enter formal schooling at age 6. Primary education lasts for five years until age 11. Curricula and learning targets are set at the national level, but teachers are completely free to choose the teaching methods they feel are best. The school year starts in early September and finishes in mid-June. In primary school, math instruction covers the domains of numeracy, relations, data and predictions, space and figures.

The INVALSI assessment tests were first administered to the entire population of Italian students in grade 8 in the school year 2007-2008. The following year, the INVALSI tests were extended to pupils in primary schools in grades 2 and 5, and over the years they have also been administered to students in grades 10 and 13.

In grade 2, pupils complete two INVALSI achievement tests: one in Italian and the other in mathematics. The Italian achievement test evaluates pupils' reading skills and degree of linguistic and metalinguistic development. The mathematics achievement test assesses pupils' math skills in different domains (numeracy, space and figures, data and predictions) and mathematical dimensions (knowing, arguing, and problem-solving) (INVALSI 2018a, INVALSI 2018b, and INVALSI 2019).

In addition to scores in grade 2, INVALSI collects data about marks given by teachers in Italian and in math at the end for the first term[4] and information about parental characteristics and family background.

Both the pre-Covid and Covid cohorts sat the INVALSI national standardised assessment in math and Italian at the end of grade 2 before the pandemic and about one year before the MATHGAP test. INVALSI provided math and Italian standardised test scores in grade 2, teachers' marks in math in the first term of grade 2, child migratory status (native children versus first- and second-generation migrant children),[5] and parental education (low- or high-educated parents, where parents are labelled as high-educated if at least one holds a tertiary degree). These data have been matched to the MATHGAP test score at the individual level.

The outcome measure, MATHGAP test

We measure pupils' math skills with the use of a math test, the MATHGAP test, which was designed by scholars of mathematics education to assess math skills acquired by children in grade 3, following the same conceptual framework as the INVALSI national assessment (see Appendix B for the MATHGAP test). The test focuses on the domain of numeracy and contains 20 test items.

[4] Teacher's marks are the marks that teachers assign to pupils at the end of the first semester, based on their overall performance during the term; they can range between 4 and 10 (6 is the pass grade).

[5] First-generation migrants are children born abroad with both parents born abroad, second-generation migrants are children born in Italy with both parents born abroad, whereas native children are born in Italy with at least one parent born in Italy (see Table A1).

Like the INVALSI tests, MATHGAP assesses different topics and mathematical dimensions; it contains both open and multiple choice-type answers. Each correct answer received 1 point and incorrect or missing answers received 0 points. Total possible scores could therefore be between 0 and 20 points, which was then standardised to have a zero mean and a standard deviation equal to 1.

The MATHGAP test was designed as part of a project conducted during the school year 2018-19, aimed at evaluating the impact of teaching practices based on active and cooperative learning on the gender gap in mathematics (MATHGAP project, Di Tommaso et al. 2021).[6] The impact was evaluated in a randomised controlled trial conducted in 25 primary schools (50 classes) of the province of Torino who volunteered to take part in the project. Randomisation was done at the class level: one class per school in the treatment group and one class in the control group. As part of the project, the test was first assessed during a pilot phase, through item-response-theory models and qualitative interviews with pilot-teachers; it was then administered at the end of April 2019 as a post-treatment test to approximately 1,000 children in grade 3.

Leveraging on the data collected within the MATHGAP project, the same test was then administered to the classes participating in the present study, to measure the math skills of children in grade 3 who experienced the Covid-19 pandemic during the school year 2019-20. With the support of the Regional Board of Education[7] of Piedmont, in May 2020 we invited the 25 schools to participate in an assessment involving all of the pupils enrolled in grade 3 during the Covid-19 pandemic outbreak. Due to the school closure until the end of the 2019-20 school year, the assessment was planned for the autumn 2020, at the beginning of grade 4, when the pupils finally returned to the classroom. The schools' enrolment in the new project was on a voluntary basis. During online presentations of the project in the summer of 2020, the application procedure was explained to school principals and teachers. Fifty-six classes from 14 schools applied. Although not all of the invited schools ended up enrolling in the study, those who did volunteered more classes than in the previous project. Therefore, the number of classes and children in the pre- and Covid cohorts were similar, as were their average characteristics (see Section 6).

For both cohorts, external tutors administered the MATHGAP test in person, to all children, including those with special educational needs and disabilities. Tutors stayed in the classroom while pupils completed the test and collected them. For the Covid cohort, the tutors returned to the school to administer the test to students who had been absent the first time.[8] The tutors then

[6] Project "Tackling the gender gap in mathematics in Italy". Project website: https://sites.google.com/view/mathgendergap.

[7] The Regional Board of Education is the regional institution of the Ministry of Education, which manages and monitors the schools at a regional level.

[8] For the pre-Covid cohort, children absent during the MATHGAP test sat it at a make-up session administered by the teacher rather than the tutor. For this reason, those tests are excluded from the analysis.

graded the tests under the supervision of an external examiner, an expert in formulating and grading Italian national standardised tests in math.

4.2 Sample selection and descriptive statistics

The initial sample was made up of 1,044 pupils in the pre-Covid cohort and 1,144 pupils in the Covid cohort, for a total of 2,188 pupils, with a similar proportion of children with special educational needs in the two groups (approximately 14%). As summarized in Table A2 in Appendix A, we exclude from the sample: i) children with special educational needs who did not perform the MATHGAP test even if they were in class (less than 0.6% of the sample); ii) children without parental consent for the release of INVALSI data (0.3% of the sample); iii) children whose data were not released by INVALSI, probably because of privacy concerns or a lack of records (about 5.3% of the sample); iv) children who were absent from the MATHGAP test or from one of the INVALSI assessment tests in grade 2 (respectively, 5.2% and 5.6% of the sample), and iv) children with other missing relevant information (teachers' marks for math during the first term of grade 2 or migratory background – 4.8%). Finally, we exclude girls from the pre-Covid cohort who received treatment (active learning teaching intervention) within the MATHGAP project. The reason for this is that these girls benefited from the intervention, whereas boys did not (see Di Tommaso et al. 2021). As a robustness check, we also exclude the treated boys, although we prefer to keep them in the main specifications to avoid the number of observations to reduce too much (see Section 5.2). As we will see, the results are very similar for the different analytical samples.

The final analytical sample thus contains 1,539 children, about 62% of which are in the Covid cohort. Table 1 presents the descriptive statistics for the overall sample as well as separately for the pre-Covid and Covid cohorts. It should be noted that MATHGAP test scores in grade 3 are standardised at the sample level, while the Italian and math test scores (INVALSI) in grade 2 are standardised at the national level (i.e. the mean is 0 for the whole Italian sample). The values in Italian and math test scores (INVALSI) indicate that our sample is positively selected with respect to the Italian population.

The proportion of natives is similar across the two cohorts, whereas the proportion of females is statistically different due to the design explained above (similar proportion before the exclusion of treated girls). Instead, the two cohorts present differences in terms of test scores and teacher's marks both in grades 2 and 3 and in the proportion of children with high-educated parents. The Covid cohort scored higher on the INVALSI Italian test (grade 2) and received higher teacher's marks in math than the pre-Covid cohort. At the same time, the pre-Covid cohort achieved higher scores on the INVALSI math test than the Covid cohort and contains a higher proportion of children with high-educated parents. The two cohorts therefore differ to some extent. However, our econometric design controls for the level of initial competences and characteristics (see the identifying assumptions in Section 3).

Table 1 – Descriptive statistics, overall and by cohort

	Overall Mean	Pre-Covid cohort Mean	Covid cohort Mean	P-value of the diff.
Math score, grade 3 (MATHGAP)	0.02	0.13	-0.05	0.00
Math score, grade 2 (INVALSI)	0.25	0.33	0.20	0.02
Italian score, grade 2 (INVALSI)	0.23	0.13	0.29	0.00
Teacher's mark in math, grade 2	8.25	8.18	8.29	0.04
Covid cohort	0.62	--	--	--
Native	0.89	0.89	0.89	0.89
High-educated parents	0.33	0.36	0.31	0.04
Observations	1,539	591	948	

Notes: T-test on the equality of means for pre-Covid and Covid cohort for each variable.
Covid cohort is the proportion of pupils belonging to the Covid cohort. Native is the proportion of natives vs. first- or second-generation migrants. High-educated parents is the proportion of children with at least one parent with a tertiary degree.
Source: INVALSI data and data collected by the research team.

5. The effect of school closure on math skills

In this section, we present our main findings of the impact of the Covid-19 pandemic on children's math achievement and the development of learning inequalities relative to gender, parental background, migrant status, and initial abilities. We then describe the results of a few robustness checks.

5.1 Main results

Table 2 shows the effects of the Covid-19 pandemic on children's math test scores in grade 3, assessed by the MATHGAP test, reporting the impact estimates when controlling only for different prior skill measures relative to grade 2 – INVALSI math and Italian test scores and teacher-assigned math marks – (column 1), and when adding the socio-demographic control variables gender, parental education, and migratory background (column 2). All specifications include school fixed effects.

These results show that the pandemic negatively affected children's math skills: the estimated loss ranges between -0.23 and -0.19 standard deviations in test scores. The magnitude of the loss is large: we could express the estimates in terms of the existing estimates of the achievement gains in a typical year. For the US, Bloom et al. (2008) estimated a gain of about 0.89 s.d. between grades 2 and 3; thus, the average impact corresponds to about 3 months of school, nearly the time that the schools remained closed in Italy. An alternative way of quantifying the magnitude of the effect is to express the impact in terms of how many percentiles of the test scores distribution the students lose on average when they have experienced school closure. In this perspective, assuming normality of the test score distribution, the average impact of the pandemic on children's test scores (-0.19 s.d.) corresponds to a downward shift in the test score distribution of about 4-5 percentile points.[9]

Moreover, since learning is a cumulative process (Cuhna et al. 2006), this short-term loss may have long-run consequences. Kaffenberger (2021) simulates that a reduction of about one third of the usual learning gains during grade 3 – assuming that no remedial efforts are made when children return to school – yields a loss equivalent to a full year of school by grade 10.

Table 2 – Main effects of the pandemic on children's math achievements in grade 3

Variables	Math score (1)	Math score (2)
Covid cohort	-0.232***	-0.188***
	(0.053)	(0.053)
Math score, grade 2	0.400***	0.386***
	(0.032)	(0.031)
Italian score, grade 2	0.107***	0.108***
	(0.024)	(0.024)
Teacher's mark in math, grade 2	0.369***	0.366***
	(0.032)	(0.031)
Female		-0.226***
		(0.031)
High-educated parents		0.077*
		(0.041)
Native		-0.055
		(0.056)
Observations	1,539	1,539
R-squared	0.562	0.575
School fixed effects	Yes	Yes

Notes: High-educated parents: at least one parent has a tertiary degree.
Clustered standard errors at class level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3 reports the heterogeneous effect of the pandemic on children's achievements according to initial skills, gender, parental education, and migratory background. The interaction with prior math test scores shows that the effect of school closures had a larger impact on well-performing pupils. Figure 1(a) helps to visualise this pattern: the point estimate of the effect of school closure for a child who scored -1 s.d. in grade 2 is -0.059 (not statistically significant), for a

[9] This is the idea: assume that the test score distribution in regular times is standard Normal. What happens to a student affected by school closure? If the z-value decreases on average by 0.19 units, the percentile of the distribution decreases by: more than 7 points at the center of the distribution (z=0.19 corresponds to P(Z<z)=0.5753, z=0 corresponds to P(Z<z)=0.5), nearly 4 points around z=1 (z=1.19 corresponds to P(Z<z)=0.8810, z=1 corresponds to P(Z<z)=0.8413), less than 1 point around z=2 (z=2.19 corresponds to P(Z<z)=0.9854, z=2 corresponds to P(Z<z)=0.9772). Very roughly, the estimate of the weighted average of the probability differences is 4-5 points.

child who scored +1 s.d. is -0.273, and for a child who scored +2 s.d. is -0.380.[10] Instead, the learning loss due to the pandemic does not differ significantly on average across family background or between girls and boys.

Table 3 – Heterogeneous effects of the pandemic on children's math achievements in grade 3

Variables	Math score (1)	Math score (2)	Math score (3)	Math score (4)
Covid cohort	-0.166***	-0.167***	-0.171***	-0.184*
	(0.053)	(0.056)	(0.061)	(0.111)
Covid cohort * Math score in grade 2	-0.107***			
	(0.039)			
Covid cohort * Female		-0.056		
		(0.067)		
Covid cohort * High-educated parents			-0.055	
			(0.074)	
Covid cohort * Native				-0.005
				(0.108)
Observations	1,539	1,539	1,539	1,539
R-squared	0.577	0.575	0.575	0.575
Initial abilities	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes

Notes: Initial abilities include math and Italian test scores in grade 2, teacher-assigned marks in math in the first term of grade 2. Socio-demographic controls include gender, native, and high-educated parents (at least one parent has a tertiary degree).
Clustered standard errors at class level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To further examine the differences between children of different socioeconomic backgrounds, we split the sample into two groups of children with low- or high-educated parents and then rerun the models with interactions. The results can be seen in Table 4. In terms of point estimates (columns 1 and 2), school closure affected the children with low-educated parents more than those with high-educated parents (-0.198 versus -0.164), but the difference is not statistically significant. The interaction with prior performance (columns 3 and 4) is significant only for the children with low-educated parents, with an impact that reaches -0.51 s.d. for the children who scored +2 s.d. in grade 2 (also see Figures 1b and 1c).[11] We also observe relevant gender differences: among the children with high-educated parents, girls were less affected by school closure than boys, although the difference is not significant (column 6). Instead, among the children with low-educated parents, the learning loss experienced by girls (-0.29) was much larger than that experienced by boys (-0.13) (column 5). This result is particularly alarming if we

[10] These figures can be obtained from the estimates in Table 3: -0.059=-0.166-1*(-0.107); -0.273=-0.166+1*(-0.107); -0.380=-0.166+2*(-0.107).
[11] We tested the assumption of linearity but found no evidence of non-linearity.

consider that even in ordinary times girls usually do worse than boys in math and math-related subjects.

Table 4 – Heterogeneous effects of the pandemic on children's math achievements, by parental education

	Low-edu parents	High-edu parents	Low-edu parents	High-edu parents	Low-edu parents	High-edu parents
	Math scores	Math scores	Math scores	Math scores	Math scores	Math scores
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Covid cohort	-0.198***	-0.164**	-0.181***	-0.161*	-0.133*	-0.201**
	(0.065)	(0.073)	(0.062)	(0.082)	(0.070)	(0.085)
Covid cohort * Math scores grade 2			-0.166***	-0.006		
			(0.048)	(0.080)		
Covid cohort * Female					-0.164*	0.110
					(0.092)	(0.126)
Observations	1,038	501	1,038	501	1,038	501
R-squared	0.585	0.523	0.590	0.523	0.586	0.524
Initial abilities	Yes	Yes	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
School fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

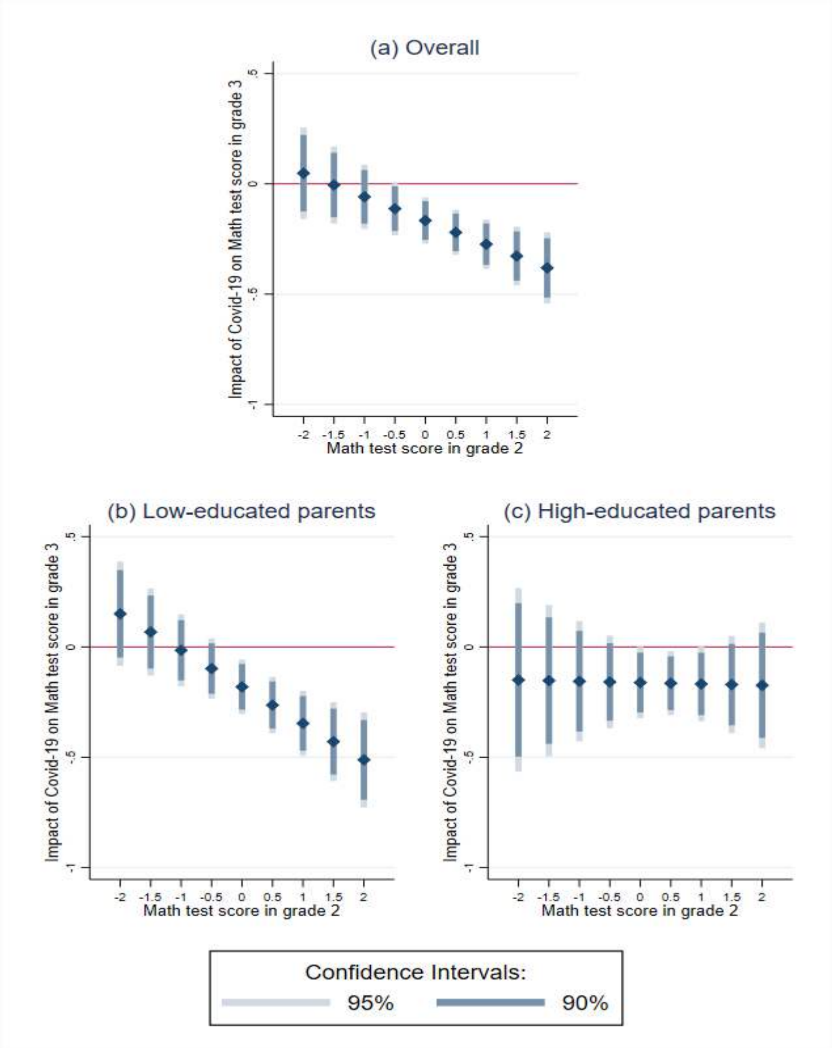
Notes: Low-educated parents: no parent has a tertiary degree. High-educated parents: at least one parent has a tertiary degree. Initial abilities include math and Italian test scores in grade 2, teacher-assigned marks in math in the first term of grade 2. Socio-demographic controls include gender and migratory background.
Clustered standard errors at class level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The mechanisms underlying these results deserve further discussion.

Only a few contributions in the literature report results by gender. There is some evidence that the pandemic had a greater detrimental effect on boys than on girls, but those studies do not differentiate by SES (Champeaux et al. 2020, Haelermans et al. 2021). In contrast, when focusing on socio-emotional skills, Mendolia et al. (2021) point to stronger effects among girls, particularly from lower-income families. These contrasting results may be generated through different channels. Boys from disadvantaged families have more behavioural and academic problems than girls from similar families (Figlio et al. 2019). One may thus expect boys to be more negatively affected by school closure than girls. However, if parents are aware of this difference and try to compensate for it, the results could reverse. Indeed, Del Bono et al. (2021) found that, for the UK, boys spent less time on schoolwork but, at the same time, received more parental help.

Heterogeneous effects in terms of prior achievement have not been previously investigated, although they are acknowledged to be very important. How can we explain the finding that high-performing students from low-SES backgrounds suffer the strongest negative effects? High-performing children from low-SES backgrounds are presumably those who benefit most from attending school. We speculate that, even in the absence of differences in terms of parental time investment by socioeconomic background (Del Bono et al. 2021), other differences may emerge, such as the parents' ability to support their children effectively. The literature is relatively silent on this point. There exists abundant evidence on the different educational outcomes of children from different backgrounds, but less so on the relative importance of school for high and low-achieving children with similar backgrounds. One notable exception is the paper by Crawford et al. (2017). They show that, on average, initially high-achieving children from poor families quickly lose ground compared with their wealthier peers; however, the effect is largely diminished when focusing on children attending the same school. This suggests that the school system may help mitigate the impact of family background on child outcomes (OECD 2018), supporting the view of school as the "great equalizer" (Horace Mann 1848). Hence, the pandemic and consequent school closures had a greater detrimental impact on the children who could have gained most from the traditional classroom, and increased educational inequalities.

Figure 1 – Effects of Covid-19 on math skills by initial math skills, overall and by parental education



Notes: Low-educated parents: no parent has a tertiary degree. High-educated parents: at least one parent has a tertiary degree.

5.2 Robustness checks

To confirm the validity of our results, we perform two robustness checks. First, we replicate the analysis excluding the boys exposed to treatment in the MATHGAP project. In the previous section, the analytical sample for the pre-Covid cohort was made up of the children participating in the MATHGAP project, excluding the girls in the treatment group, because the evidence is that they had benefited from the intervention, whereas boys had not (Di Tommaso et al. 2021).[12] We now replicate the analyses by also excluding the boys in the treatment group; the reason for this is that although the average treatment effect for boys was null, we cannot exclude that none of the boys were affected by exposure to the active learning intervention. Our previous findings are largely confirmed, both in terms of the direction and magnitude of the estimates (Table 5, column 1).

Second, we estimate a model without school fixed effects, but including class-level variables (share of females, of natives, of children with high-educated parents, and average test scores) in grade 2 to control for the different contexts. Once again, the previous findings are confirmed (Table 5, column 2). We also estimate a model with interactions between the Covid cohort dummy and context variables at the school level. The interactions are not significant, suggesting that, once controlling for individual characteristics, the effect of the pandemic on math scores does not vary with school characteristics.[13]

Table 5 – Robustness checks

Variables	Math scores (1)	Math scores (2)
Covid cohort	-0.200***	-0.154**
	(0.057)	(0.064)
Observations	1,346	1,539
R-squared	0.573	0.532
Initial abilities	Yes	Yes
Socio-demographic controls	Yes	Yes
School fixed effects	Yes	No
Context variables (class level)	No	Yes

Notes: In column 1, we exclude boys treated during the MATHGAP project; in column 2, we substitute school fixed effects with contextual variables computed at the class level. Initial abilities include math and Italian test scores in grade 2, teacher-assigned marks in math in grade 2. Socio-demographic controls include gender, native, and high-educated parents (at least one parent has a tertiary degree). Contextual variables at the class level include the proportion of females, natives, and children with high-educated parents, and the average math and Italian test scores in grade 2.
Clustered standard errors at class level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

[12] In addition to being non-statistically significant, the point estimate of the effect of the MATHGAP intervention was practically 0 for boys, and the result was robust to different specifications. Interestingly, there is also preliminary evidence that this is also the case in the medium run.

[13] Results available from the authors upon request.

6. Possible limitations

The present analysis has two main limitations, which are presented and discussed hereafter.

6.1 Timing of the math test in grade 3

Pupils of the pre-Covid cohort sat the MATHGAP test at the end of grade 3 (the end of April 2019), whereas the pupils of the Covid cohort sat the test at the beginning of grade 4 (October 2020). This misalignment could have two opposite effects. On the one hand, the children in the Covid cohort are a bit older and more mature, and had attended at least one and a half more months of school (May in grade 3 and September in grade 4). Thus, the estimated effect of the pandemic might be downward biased. On the other hand, the children in the Covid cohort had also gone through the summer break, potentially responsible for learning losses. In this perspective, the estimated effect would be upward biased, because the observed change would not be entirely attributable to the pandemic, but it is also due to the summer break. The two effects may cancel out, but the net effect of the two opposite forces is not known a priori. The rough existing estimates of the summer learning loss point to a reduction of about -0.10 standard deviations (Sloan McCombs et al. 2011 – estimates for the US): if we trusted these estimates and disregarded the potential opposite bias, since our ATE estimate is about 0.2 standard deviations, we would conclude that there is still evidence of a sizeable negative effect of the pandemic.

6.2 Self-selection of schools and external validity

Our sample of schools might be affected by self-selection, given that only 14 out of the 25 schools invited to participate eventually took part in the post-Covid assessment. To assess the degree of self-selection, we first compare the 14 schools that agreed to participate in the project with the 11 schools that did not. To do so, we rely on INVALSI data available for both groups of schools, including the composition of classes, pupils' characteristics, math and Italian skills in grade 2. We present the mean at the school level using class averages of INVALSI data for classes in grade 2 in the school year 2017-18. We find few statistical differences between the two groups of schools: in the 14 schools who participated in the new project, the children were more likely to have attended kindergarten, but their parents were less educated; no differences emerge in terms of their math or Italian abilities (Table A3 in Appendix A). However, we cannot rule out that the two groups of schools differ in how they coped with distance learning. Since we lack information in this regard, we cannot test for any such difference. Nonetheless, if any self-selection occurred, we would expect it to be positive, i.e. that the schools coping better with distance learning were more likely to participate. If so, our estimates would represent a lower bound of the true causal effect of school closure.

To assess external validity, we compare the average characteristics at the class level of the 14 schools with the same characteristics at the regional and national level (pre-Covid cohort).[14] There is evidence that the children in our schools are more skilled on average and have a higher proportion of high-educated parents than the children in Piedmont and Italy as a whole (Table 6). Moreover, since these schools are located in the province of a large city rather than in rural or remote areas, we can expect the children and teachers to have better technological tools and broadband access at home. This means that our findings probably underestimate the effects of the pandemic on pupils' achievements at the national level.

Table 6 – Comparison of participating 14 schools with regional and national data

Variable	Classes in our schools' sample	Piedmont Classes	P-value of the difference our sample vs. Piedmont classes	Italian Classes	P-value of the difference our sample vs. Italian classes
Average number of pupils per class	20	19	0.04	18	0.00
Female	0.50	0.51	0.70	0.49	0.50
Pre-kindergarten (age 0-3)	0.37	0.32	0.16	0.38	0.82
Kindergarten (age 3+)	0.99	0.89	0.00	0.94	0.03
Migrant 1st generation	0.01	0.02	0.17	0.03	0.10
Migrant 2nd generation	0.10	0.15	0.04	0.13	0.10
INVALSI Italian score std., grade 2	0.51	0.09	0.00	0.02	0.00
INVALSI Math score std., grade 2	0.52	0.03	0.00	0.02	0.00
Mother's level of education					
Primary school	0.00	0.02	0.03	0.02	0.01
Lower secondary school [a]	0.27	0.33	0.04	0.31	0.10
Upper secondary school [b]	0.45	0.44	0.62	0.43	0.38
Tertiary degree	0.27	0.22	0.04	0.24	0.09
Father's level of education					
Primary school	0.01	0.01	0.03	0.03	0.01
Lower secondary school [a]	0.40	0.45	0.05	0.40	0.86
Upper secondary school [b]	0.41	0.38	0.15	0.41	0.80
Tertiary degree	0.19	0.16	0.16	0.16	0.10
Number of classes	81	75		1,482	

Notes: Std. = Standardised (mean 0, st.dev. 1). [a] Includes also vocational qualification. [b] Includes also Post-diploma qualification.

As just mentioned, the available data contain no information about how schools responded to the pandemic. For this reason, we administered a short questionnaire on distance learning to the teachers of the Covid cohort (Table 7). The response rate was quite high, 71.43% (40 out of

[14] For the regional and national schools, we use INVALSI data of classes belonging to the so-called representative sample, to whom the national test is administered under external supervision, reducing the risk of cheating.

56 teachers), although not all of them answered all the questions. Overall, 85% of the teachers reported that they provided some type of distance learning activities during the lockdown of March-June 2020. Seventy-nine percent of the teachers stated that the distance learning activities consisted mainly of streaming live lessons. By means of comparison, at the national level Champeaux et al. (2020) report that, in primary school, online classes were offered to 65% of pupils and Scarpellini et al. (2021) report a percentage of 81.6 (non-representative online surveys). These figures suggest that the share of children exposed to some distance learning – as opposed to no school at all – was not smaller in our sample than at the national level. Thus, we should not worry about our results being overestimates of the true effect of school closure because of lower exposure to some form of instruction.

Table 7 - Descriptive statistics of the teachers' survey

Variable	Obs.	Mean	Std. Dev.	Min	Max
Female (teacher)	40	0.98	0.16	0.00	1.00
Teacher's age	40	49.33	9.75	25	63
Full time (class)	40	0.65	0.48	0.00	1.00
Distance learning					
Distance learning [a]	39	0.85	0.37	0.00	1.00
Simultaneous distance learning [b]	33	0.79	0.42	0.00	1.00
Hours of distance learning per week	33	8.38	4.89	1.50	20.00
Teacher opinion about distance learning [c]	35	3.20	0.80	1.00	5.00

Notes: Data from the questionnaire completed by math teachers of the Covid cohort classes in the sample. Response rate 71.43%. [a] Distance learning: 1 if some distance learning was provided, 0 otherwise. [b] Simultaneous distance learning: 1 if simultaneous distance learning was provided, 0 otherwise. [c] 1-5 scale.

7. Discussions and conclusions

The Covid-19 pandemic has caused long periods of school closure, often coupled with severe lockdowns, causing an unprecedented disruption to children's lives and their learning process. Italy was the first Western country hit by the pandemic, and the one with the longest period of school closure in spring 2020. In this paper, we present the first estimates of the effects of the pandemic on the learning losses and educational inequalities among Italian pupils enrolled in primary school.

This research estimates the effect of the pandemic on the math performance of children in grade 3 with a difference-in-difference strategy. We use a unique dataset, constructed by matching scores in a standardised math test administered at the end of grade 3 with the scores from the national standardised assessment in grade 2. The data have been collected for a sample of about 2,000 children, enrolled in primary school in the province of Torino, a large metropolitan area located in the north of Italy.

Children faced large learning losses during the spring 2020, i.e. the first Italian lockdown, with an average impact of -0.19 standard deviations. The magnitude of the loss is large, and corresponds to about 3 months of school, nearly the time that the schools remained closed in Italy. Our results end up being similar to the findings from previous research on different countries: learning loss due to school closure is about 0.01 s.d. for each week of school closure (in Italy -0.19 s.d. for 15 weeks of closure, in other countries 0.07-0.10 s.d. for about 8-10 weeks).

On average, we find no evidence of stronger effects among children from disadvantaged backgrounds. Instead, our results reveal that the school closure had a larger negative impact on well-performing pupils with low-educated parents. Moreover, among children with low-educated parents, the learning loss experienced by girls was double that of boys. We might speculate that high-performing children (and perhaps girls) from disadvantaged backgrounds are probably those who have previously benefited most from school attendance and who are more likely to benefit more in the future. If these children are the ones who were hurt the most by the school closure, the consequence is likely to be that learning inequalities increase, at least in the upper part of the performance distribution.

Indeed, the 2020 school closure had a large negative impact for many children. If we add to this the possible effects of distance learning many children also experienced during the following school year, and the cumulative effects these initial losses might develop over time, we can expect dramatic long-term consequences on an entire generation of young people.

These findings call for urgent policy actions to be taken. On the one hand, strategies need to be put in place in order to limit other school closures in the unfortunate event of a resurgence of the pandemic. On the other, remedial measures should be introduced to limit the damage already occurred, to help the pupils who might otherwise be left behind, at the same time fostering learning among the (more or less) talented children who would have been able to reach learning targets in a traditional classroom learning environment, but were disadvantaged by distance learning.

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Appendices

Appendix A

Table A1 – Variable definition

Variable	Definition
Individual level	
Math test score, grade 3	Standardized math test score in MATHGAP test, grade 3
Math test score, grade 2	Score in Math INVALSI test, grade 2 (standardised at national level)
Italian test score, grade 2	Score in Italian INVALSI test, grade 2 (standardised at national level)
Teacher's mark in math, grade 2	Teacher's mark in math, first term grade 2 (mark that teachers assign to pupils at the end of the first semester, based on their overall performance during the term; it can range between 4 and 10, and 6 is the pass grade)
Covid cohort	1 if Covid cohort, 0 if pre-Covid cohort
Female	1 if female, 0 if male
Native	1 if the child is born in Italy with at least one parent born in Italy, 0 otherwise
Low-educated parents	1 if no parent has a tertiary degree, 0 otherwise
High-educated parents	1 if at least one parent has a tertiary degree, 0 otherwise
Class level	
Average number of pupils per class	Average number of pupils per class
Female	Percentage of females in class
Pre-kindergarten (age 0-3)	Percentage of pupils who attended pre-kindergarten (age 0-3)
Kindergarten (age 3+)	Percentage of pupils who attended kindergarten (age 3+)
Migrant 1st generation	Percentage of children born abroad with both parents born abroad
Migrant 2nd generation	Percentage of children born in Italy with both parents born abroad
INVALSI Italian score std., grade 2	Mean of INVALSI Italian score standardised (at national level), grade 2
INVALSI Math score std., grade 2	Mean of INVALSI Math score standardised (at national level), grade 2
Mother/father's level of education	
Primary school	Percentage of mothers/fathers with a primary school degree
Lower secondary school	Percentage of mothers/fathers with a lower secondary school degree or vocational qualification
Upper secondary school	Percentage of mothers/fathers with an upper secondary school degree (diploma or post-diploma qualification)
Tertiary degree	Percentage of mothers/fathers with a tertiary degree
Teacher questionnaire	
Distance learning	1 if some distance learning was provided, 0 otherwise
Simultaneous distance learning	1 if simultaneous distance learning was provided, 0 otherwise
Hours of distance learning per week	Number of hours of distance learning the teacher provided
Teacher's opinion about distance learning (1-5 scale)	Opinion of the teacher on distance learning (1=negative; 5= positive)
Female (teacher)	1 if the teacher is female, 0 otherwise
Teacher's age	Age of the teacher
Full time (class)	1 if the class has a full-time schedule (40 hours per week), 0 otherwise (27/30 hours per week)

Table A2 – Sample selection

Sample	Overall	Pre-Covid cohort	Covid cohort
Initial sample	2,188	1,044	1,144
Pupils with special educational needs who did not perform the math test in grade 3	12	4	8
Lacking parental consent for INVALSI data[1]	7	2	5
Not released by INVALSI[2]	115	50	65
Absent from the MATHGAP math test, grade 3	106	50	56
Absent from one of the INVALSI assessment tests, grade 2	110	67	43
Missing other relevant information[3]	89	70	19
Females in treated classes of MATGHAP project	210	0	0
Final sample	1,539	591	948

Notes: [1] Children without parental consent for the release of INVALSI data or lacking an INVALSI identification number. [2] Data were not released by INVALSI, probably because of privacy concerns (matching) or due to missing records. [3] Children without complete information about teacher-assigned marks in math in the first term of grade 2 and/or migratory background.

Table A3 – Comparison between the 14 schools of the Covid cohort and the 11 other schools from the original pre-Covid sample

	14 schools Applied	11 schools Not applied	P-value of the diff.
Females	0.50	0.50	0.97
Pre-kindergarten (age 0-3)	0.37	0.43	0.18
Kindergarten (age 3+)	0.99	0.90	0.02
Migrant, first generation	0.01	0.01	0.96
Migrant, second generation	0.10	0.07	0.08
INVALSI Italian score standardized, grade 2 [a]	0.51	0.40	0.25
INVALSI Math score standardized, grade 2 [a]	0.52	0.47	0.68
Mother's level of education			
Primary school	0.00	0.01	0.89
Lower secondary school [b]	0.27	0.21	0.02
Upper secondary school [c]	0.45	0.42	0.31
Tertiary degree	0.27	0.36	0.01
Father's level of education			
Primary school	0.01	0.01	0.06
Lower secondary school [b]	0.40	0.33	0.03
Upper secondary school [c]	0.41	0.39	0.42
Tertiary degree	0.19	0.27	0.01
Number of classes	81	55	

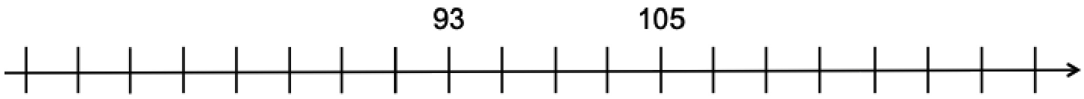
Notes: [a] Standardized scores, with 0 mean and 1 standard deviation. [b] Includes also vocational qualification. [c] Also includes post-diploma qualification.

Appendix B (For Online Publication)

MATHGAP test

NAME …………………………………… **GOOD LUCK! ☺**

1) Look at the number line.



Write these numbers on the line: 90 and 99 and 114.

2) Think about the number 940.

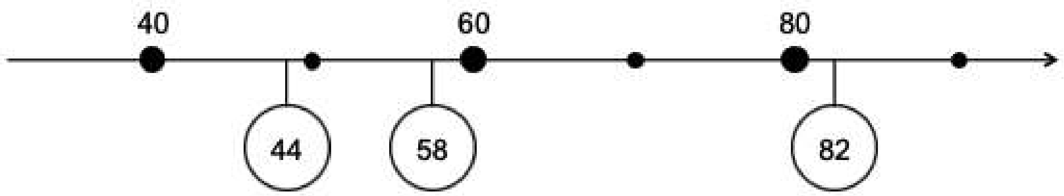
a. What digit is in the tens place?

Answer: ……

b. How many tens make up the number 940?

Answer: …… tens

3) Look at the number line:

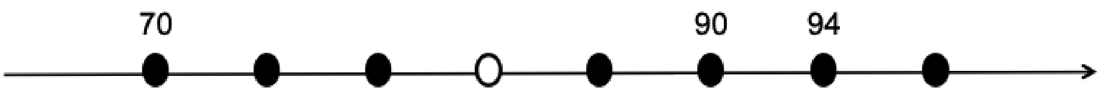


The number in one of the circles is wrong.

The wrong number is:

A. 44
B. 58
C. 82

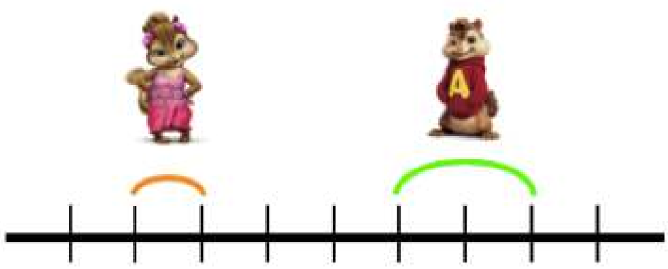
4) Look at this figure:



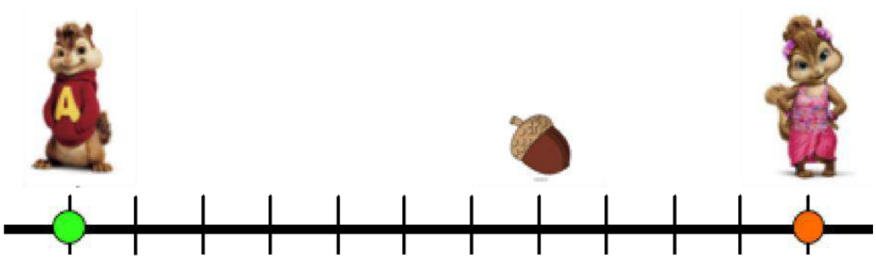
What number can you put over the white circle?

Answer: …………

5) Chippie and Chip are racing to get an acorn.
Here is Chippie's step and Chip's step:



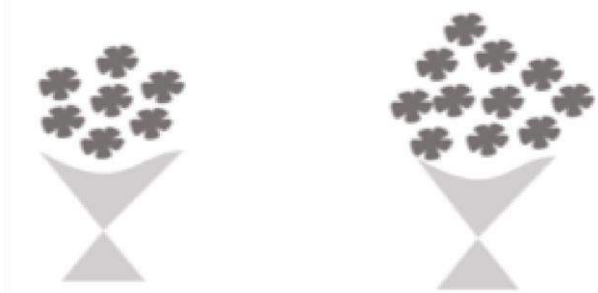
These are their positions at the beginning:



a. How many steps does Chippie have to take to arrive exactly at the acorn?
Answer: ………… steps

b. How many steps does Chip have to take?
Answer: ………… steps

6) Eliza has two bouquets:



BOUQUET A BOUQUET B

Eliza wants both bouquets to have the same number of flowers.
What does she have to do?

Complete the sentence:

Eliza moves ………… flowers from bouquet ………… to bouquet ………… .

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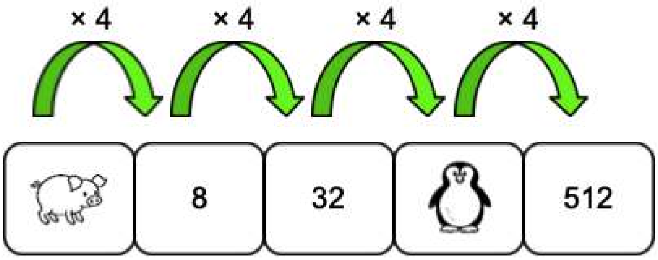
7) Mr. Andrew, the teacher, prepares colored pencils for the class. He has 5 hundreds, 68 units and 3 tens.

a. What operation does Mr. Andrew use to count how many pencils he has?
   A. 50 + 3 + 68
   B. 500 + 30 + 68
   C. 68 + 3 + 500

b. Mr. Andrew takes only the red, blue and green pencils: he counts 120. He has 25 students in his class.
   Can Mr. Andrew give 5 pencils of these colors to each student?
   A. Yes, with 5 pencils left over.
   B. No, he doesn't have enough pencils.
   C. Yes, and he has no red, blue or green pencils left over.

8) Look at this picture:



a. What number is hidden behind the piglet?
   Answer: …………

b. What number is hidden behind the penguin?
   Answer: …………

9) A doll costs 7 euros and 90 cents.
Three friends have this much money:

Vittoria	
Lucrezia	
Sara	

Complete the sentence:

One of the three friends can't buy the doll: it's …………

10) Today the school cafeteria is serving pizza and French fries for lunch.
The cook made:

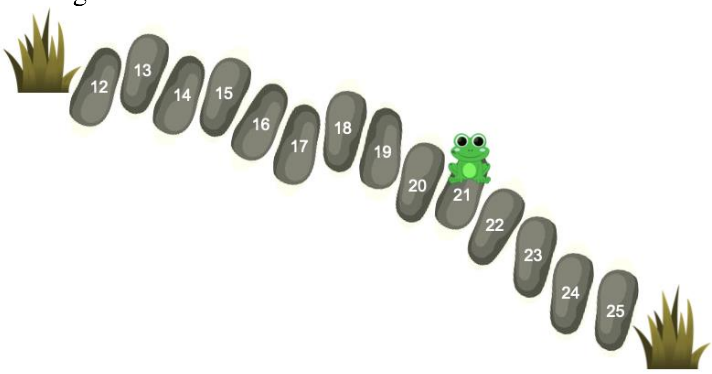
	1 pizza for every 7 children
	5 French fries for every child

There are 35 children in the cafeteria.

a. How many pizzas did the cook make?
   A. 12
   B. 5
   C. 7

b. How many French fries did the cook have to make?
   A. more than 170
   B. fewer than 150
   C. 165

11) A frog is hopping from stone to stone along a path.
Each stone is numbered as shown in the picture.
Look where the frog is now.



a. The frog hopped 7 times to get there.
   What stone was she on before hopping 7 times?
   Answer: she was on stone No. …………

b. Complete the sentence:
   If the frog had been on stone No. 25, she would have had to hop ………… times to return to stone No. 13.

12) If you add 4 units and 2 tens to the number four hundred and thirty, you get:

A. 454

B. 472

C. 436

13) Julia’s birthday is January 29 and her friend Alexandra’s is exactly 1 week later.

Gennaio 2019

Lunedi	Martedì	Mercoledì	Giovedì	Venerdì	Sabato	Domenica
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

a. When is Alexandra’s birthday?

A. January 22

B. February 2

C. February 5

b. Alexandra’s sister celebrates her birthday exactly three weeks before Julia. What day of the week did Alexandra’s sister’s birthday fall on in 2019?

A. Monday

B. Tuesday

C. Wednesday