



HAL
open science

Early Gendered Performance Gaps in Math: An Investigation on French Data

Thomas Breda, Joyce Sultan Parraud, Lola Touitou

► **To cite this version:**

Thomas Breda, Joyce Sultan Parraud, Lola Touitou. Early Gendered Performance Gaps in Math: An Investigation on French Data. 2024. halshs-04414597v2

HAL Id: halshs-04414597

<https://shs.hal.science/halshs-04414597v2>

Preprint submitted on 3 Jun 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



PARIS SCHOOL OF ECONOMICS
ECOLE D'ECONOMIE DE PARIS

WORKING PAPER N° 2024 – 01

Early Gendered Performance Gap in Math: An Investigation on French Data

Thomas Breda
Joyce Sultan Parraud
Lola Toutou

JEL Codes: I21 ; I24 ; J16

Keywords: Gender gaps; Maths performance; Education

anr [®]
agence nationale
de la recherche
AU SERVICE DE LA SCIENCE



Early Gendered Performance Gap in Math: An Investigation on French Data

Thomas Breda*
Joyce Sultan Parraud[†]
Lola Touitou[‡]

June 3, 2024

Abstract

While there is no gap in math performance at the beginning of Grade 1, a gap in favor of boys appears and widens during the first year of primary school. Using standardized national assessments administered during Grade 1 (CP) to more than 2.5 million pupils in France between 2018 and 2022, we show that this relative drop in girls' performance is observed for all the cohorts and most of the exercises assessed. The greatest drop-off occurs among the best-performing girls at the start of Grade 1 (those in the top 1 % initially). These girls lose an average of nearly 7 percentile ranks at the start of second grade compared with boys in the same initial percentile. The emergence of a gender gap in math performance during Grade 1 is observed across all social categories and family compositions, and throughout the country. Girls lose slightly less ground compared to boys in classes where the top student in math is a girl, and in priority networks public schools (REP or REP+). However, characteristics of the school environment explain only a small part of the overall dynamics, suggesting that girls are losing ground compared to boys in every strata of society.

Keywords: Gender gaps; Maths performance; Education.

JEL Codes: I21 ; I24 ; J16.

*Paris School of Economics, CNRS, Institut des politiques publiques. Email: thomas.breda@psemail.eu

[†]Institut des politiques publiques. Email: joyce.sultan@ipp.eu

[‡]Institut des politiques publiques (IPP).

We would like to thank the Women and Science Chair at Université Paris Dauphine-PSL for funding this project, and the DEPP for providing the data. We also thank participants at the IPP internal seminar are also thanked for their helpful comments. All remaining errors are our own.

1 Introduction

Examining the gender achievement gaps has revealed a paradox that emerged in the last decades: despite women outperforming men on average in school and having higher rates of high school completion, college enrollment and completion in most OECD countries, they still experience worse labour outcomes. Women are under-represented in the occupations considered to be the most prestigious or the most lucrative and this is particularly striking in the field of science, technology, engineering and mathematics (STEM), where women account for only 32% of French graduates in 2021¹. Further upstream, [Card and Payne \[2021\]](#) show that in Canada and the US, the discrepancy between men and women in high school course selection can actually explain most of the observed difference later in majors' choice in college. This under-representation is an obstacle to gender equality on the labour market: 20 to 30% of the pay gap among higher education graduates can actually be explained by differences in occupation [[Breda et al., 2023](#)].

The under-representation of women also has perverse effects for new generations – with little opportunity to interact with women engineers or scientists, young women are turning away from these occupations thinking they are not for them – while maths-related anxiety is said to be passed on from female teachers to girls ([Beilock et al. \[2010\]](#)). According to the latest results of the PISA 2022 survey, 72% of French girls aged 15 who attend school agree with the statement “I’m afraid of getting bad marks in maths”, compared with 56% of boys.

In a cumulative process, inequality and difference in academic performances very early-on may potentially have lasting impacts on women’s career choices and labour outcomes. The beginning of mandatory schooling has furthermore been shown to be a critical period for children internalising gender stereotypes [[Duru-Bellat, 2008, 2016](#)] and associating men more than women with high-level and presumed innate intellectual abilities (gender-brilliance stereotype). [Bian et al. \[2017\]](#) are interested in the acquisition of this stereotype by children: when it comes to imagining a particularly intelligent person, children make no difference according to gender at the age of 5, whereas from the age of 6 girls begin to imagine a man, and they also tend to refuse to take part in games identified as being for very intelligent people. Performance at school can ultimately reinforce the influence of such gender stereotypes through a confirmation effect. They can also directly affect pupils’ self-confidence and lead to disinvestment in certain subjects in which they consider themselves to be less talented, thus contributing to the under-representation of women in science [[Napp and Breda, 2022](#)].

For math, using PISA data, boys have been shown to outperform girls at the age of 15 in most OECD countries. Longitudinal studies such as [Fryer Jr and Levitt \[2010\]](#) in the US have also shown a widening of girls’ disadvantage over time. Furthermore, recent works have demonstrated that those gender gaps can be highly heterogeneous, and depend for instance on family socio-economic

¹The breakdown of new graduates by gender and by field can be consulted [on the OECD website](#)..

status or race (Penner and Paret [2008]). Using a sample of Australian primary school students, Cobb-Clark and Moschion [2017] find that the unconditional raw gender gap is highest at the top of the distribution, and that patterns differ when considering students of different socio-economic background separately.

Although gender gaps in performance are well documented, factors explaining their level and evolution do not foster consensus, especially as to their relative importance. Drawing from gender socialisation theories, subfields of the literature have looked into the influence of the family, peers, and institutions. In particular, schools and other educational institutions are critical environments for internalising gender stereotypes. Interactions between teachers and pupils or between pupils and pupils (peer effects) can influence the relative performance of girls compared with boys. Girls whose teachers (either female or male) have significant gender biases conform to their teachers' beliefs and perform less well ("self-fulfilling prophecy"). Terrier [2020] shows that having a teacher who gives better marks to girls than to boys (for equal performance) durably increases their performance and their probability of going into science. In Italy, for secondary school pupils, Carlana [2019] shows that having a teacher with implicit biases associating math more with boys degrades girls' self-confidence and contributes to the gender gap in math, while Lavy and Sand [2018] document the persistence of the effect of having been exposed in primary school to a biased teacher over time in Israel. Dee 2005, 2007 show that having a teacher of the same gender improves middle school performance for both girls and boys in the United States (role model effects). Finally, there is less consensus on the influence of the gendered composition of classes or schools: some studies conclude that there is a positive effect on the mathematical results of girls in non-mixed environments (see Paredes [2022] in Chile), while others point to negative effects on the choice of scientific subjects (see Brenøe and Zölitz [2020] for Denmark).

The aim of this paper is to document the gender gap in math that is likely to emerge from the start of primary school – i.e. at the age of 6 for the majority of pupils – and its possible causes. We use data coming from compulsory standardised national assessments administered to more than 2.5 million pupils in Grade 1 ("*cours préparatoire*") and Grade 2 ("*cours élémentaire première année*") between 2018 and 2022 (see Section 2). The absence of any notable change in French (figure 1) has led us to focus mainly on the math assessments, but we present some results related to French in appendix (Section 6). The ground lost by girls relative to boys in math has already been shown in France by the *Conseil scientifique de l'éducation nationale* Martinot et al. [2021] and the DEPP [2023]. Fischer and Thierry [2022] also show on survey data that boys start outperforming girls in math around age 6 in France. We are continuing this body of work and attempting to understand the factors likely to push girls falling behind boys in math.

The remainder of the paper is structured as follows. Section 2 describes the data as well as details the construction of scores and variables used in the analysis. Section 3 describes the evolution of

the performance of boys and girls in math and reading in Grade 1 (age 6) and how the gender gap in this evolution varies according to initial performance and family background. Section 4 presents the main results from multivariate analyses and section 5 concludes.

2 Data

2.1 Data sources

2.1.1 *Évaluations Repères CP-CE1: scores*

Created by the French Ministry of Education in 2018, the evaluations are exhaustive standardized national assessments. These assessments are designed to detect learning difficulties and concern all pupils of Grade 1 (*Cours préparatoire* or “CP”) and Grade 2 (*Cours élémentaire première année* or “CE1”), enrolled in state and private schools under contract. They are carried out in class, under the guidance of the teacher, and take place in three sessions: the first at the start of Grade 1 (September), then in January during Grade 1 and finally in September at the start of Grade 2. The results of the assessments are entered by the teachers and summarized. They are communicated to families, school headmasters and teachers in the form of personal feedback sheets (radar charts).

The exercises (items) assessed do not cover the whole curriculum, but are selected to test certain skills in math (e.g. adding numbers, solving problems) and French (e.g. writing syllables, reading a text aloud), and for each item difficulty thresholds are defined in order to identify struggling pupils. The exercises may vary between different assessment sessions and between cohorts. Grading scales are also not consistent across cohorts and assessments, which means that they cannot easily be used to measure pupils’ absolute progress over time or differences in absolute performance between cohorts. Therefore, results are standardized for each cohort and evaluation session (see the “Pupils’ scores and gender gaps” section).

2.1.2 *Constats de rentrée en sixième: pupils’ family background*

Information on pupils’ socioeconomic background is merged with the test scores for the first cohort (in Grade 1 during 2018-2019) using a different data source, which is completed by families when their children enter middle schools. Information on pupils’ socioeconomic background is therefore retroplated as we use family information collected when pupils enter Grade 6 (*sixième*).

Two pieces of information are available: the relation of each legal representative (up to three) to the pupil, and their occupation (*Profession et Catégorie Socio-professionnelle*) coded in 29 categories. From the parents’ occupation categories, we reconstruct the individual SES index (*Indice de Position Sociale*²) of the legal representatives and the family SES index, using the Ministry of Education

²The IPS is a continuous index created by the Ministry of Education to describe pupils’ socioeconomic background.

cross-tabulations³ (see Figure 4). We also reconstruct the family types shown in Figure 5, based on the child’s legal representatives. If the child has only one declared parent, he or she belongs to a single-parent family; if he or she has two parents of the same sex, he or she belongs to a one-parent family. Children with a father and a mother are considered to be part of a heterosexual family.

2.1.3 Aide au Pilotage et à l’Auto-Évaluation du premier degré: schools

Administrative information on the characteristics of schools is available in the APAE 1D application and merged with the previous data sources. These data include information on the type of school (public, private) and whether or not the school belongs to a priority education network (*Réseau d’Education Prioritaire* (defined on the basis of the social composition of schools and the proportion of underprivileged pupils). It also includes aggregated information on pupils’ characteristics (average number of pupils per class, proportion of girls, school SES index corresponding to the average SES index of pupils in the school) and teachers’ characteristics (proportion of female teachers in the school, average age of teachers, average length of service in the school). Schools’ characteristics are available for each cohort.

2.2 Data processing

2.2.1 Cleaning of *Évaluations Repères CP-CE1*

Some observations have been omitted from the data in the following cases:

- When the pupil identifier is missing;
- If there is too much variation in gender or date of birth;
- Where a pupil is assessed in more than one school for a given assessment.

If a pupil is assessed in several classes (within the same school) for a given assessment, we keep the observation by taking the average of the scores and deleting the class information. For pupils who have several inconsistent scores for some items during an assessment, we take the average of these scores.

2.2.2 Pupils’ scores and gender gaps

In the following, results are standardized for each cohort and evaluation session.

To give a similar weight to every item, items are first transformed into Z-scores. For item j and student i :

$$\tilde{item}_{ij} = \frac{item_{ij} - \overline{item_j}}{\sigma(item_j)}$$

³Available here: <https://www.education.gouv.fr/media/158757/download>

If pupils are evaluated on all items for a given assessment and subject, we then aggregate the math and French averages and standardize again.. Otherwise, the aggregate scores are missing. See the ‘Sample retained’ section below for more information on missing scores.

$$score_i = \frac{x_i - \bar{x}}{\sigma(x)} \quad \text{with } x_i = \frac{\sum_{j=1}^n item_{ij}}{n} \text{ and } n \text{ the number of items evaluated}$$

Finally, the aggregate math and French scores are then standardized into percentile ranks, which allow us to assess the relative position of each pupil in the distribution of their cohort (100 being the highest possible value). The higher a pupil’s score, the better he or she is performing and the higher his or her percentile rank. A pupil with a score that gives a percentile rank of 65 means that the pupils has achieved a result that is better or equal to 65 % of his or her cohort.

$$rank_i = 100 \times \frac{N_i}{N - 1} \quad \text{with } N_i = \sum_{s \neq i}^N \mathbb{1}(score_s < score_i) \text{ and } N \text{ the sample size}$$

Progress outcomes are the difference between the percentile ranks at the beginning of Grade 2 and Grade 1.

Gender gaps in scores and progress are defined as the difference between the average scores or ranks of boys and girls. When positive, they indicate an advantage for boys and vice versa.

2.2.3 Other variables

We create supplementary variables to further characterize pupils, class and schools from different text fields of our data sources.

- Teachers’ gender is inferred from a text field related to class name in *Évaluations Repères CP-CE1*, that sometimes contains the name and gender titles of teachers (e.g. "Classe de CP-A de Mme X"). We code three modalities: male, female, unknown (respectively 3 %, 26 % and 71 % of all observations) and use female as the baseline in regression analysis.
- Classes’ characteristics are reconstructed at the cohort times school level using a class number when available, or the class name field (both in *Évaluations Repères CP-CE1*) when not. Class characteristics depend on observed pupils, for instance the number of pupils in a class. Variables related to peers, such as the gender gap in math in the class at the beginning of Grade 1, or the average performance of class peers in math are computed leaving the considered pupil’s own observation out.
- Pedagogy and religion are variables created at the school level respectively using school names and school names and type (only private schools can be offer religious instruction in France) and looking for explicit mentions of alternative pedagogies (“Montessori”, “Freinet”, etc.) or specific usual words (“Saint” for Catholic schools) in the APAE data. We find that 8 % of pupils

attend private religious schools (and represent 61 % of pupils enrolled in private schools). The bulk of these observations are pupils attending Catholic schools (230,482 pupils at the beginning of Grade 1), then Jewish schools (3,416 pupils) and very few Muslim schools (121 pupils). Regarding schools with alternative pedagogies, we classify less than 1 % of pupils as attending those schools. In detail, at the beginning of Grade 1 we have 2,312, pupils attending schools that we could identify as using the Freinet pedagogy, 775 pupils in schools using the Montessori pedagogy and 83 pupils in a school using the Steiner-Waldorf pedagogy.

3 Descriptive Analysis

3.1 Sample selection

For a given evaluation within a cohort (beginning and middle of Grade 1, beginning of Grade 2) between 10 and 15% of students' results are missing. We check that missingness does not appear to be related to gender or schools. When computing statistics we use all available observations for a given assignment and do not restrict the sample to pupils with no missing evaluation. In practice, this means that the students observed at the beginning, middle of Grade 1 and beginning of Grade 2 are not exactly the same in the gender gap Figures. When defining initial percentile ranks in regressions or Figures it is relative to the pupils observed at the beginning of Grade 1 (but not necessarily afterwards). Note that our results are robust to restricting the sample to the pupils evaluated in the three assessments.

Some pupils appear to switch school during the Grade 1. Because we use school fixed effects and controls in the regressions, we exclude those that switch between the beginning and middle of Grade 1 evaluations from the sample regressed.

3.2 Gender gaps in math and French

Looking at all the cohorts from 2018 to 2022 (Figure 1), there is almost no difference in the average rank between boys and girls in math when pupils enter Grade 1. Girls, on the other hand, are better in French (their average rank per hundred pupils is 5.5 percentile ranks higher on average than that of boys). The gap in math appears at the second assessment in the middle of the Grade 1, in January (2.7 ranks), and widens at the last assessment. At the end of Grade 2, boys are on average 5.8 ranks ahead of girls, which corresponds to an average mark difference of just over 1 point out of 20. In French, the dynamic appears to be different, as the initial advantage for girls is reduced in the middle of Grade 1 (from 5.5 to 2 ranks), before increasing again at the start of Grade 2 (4 ranks).

Identical results were observed for each of the four cohorts studied (see Figure A4 in appendix): every year, including during the years 2019-2020 and 2020-2021, which were severely affected by the

Covid-19 pandemic, girls' began to lose ground in math compared to boys as early as five months after starting Grade 1, falling behind even further at the beginning of Grade 2.

Statistics on the distributions of math and French scores for both gender separately are provided in Table A1 and Figure A1 in appendix. Looking at the math densities, boys and girls densities quite clearly shift away from one another over time, while there is no such pattern in French. An additional finding in line with the related literature is that the distribution for boys is more spread out than for girls (more extreme performers).

3.3 Gender gaps by item

A potential caveat to the previous finding is that because the content of the evaluations is not the same at the beginning of Grade 1, middle of Grade 1 and beginning of Grade 2, girls falling behind boys over time when considering the aggregate math's score could be due to a change in content rather than actual evolution of boys and girls relative ranking. To account for this concern, Figure 2 shows the evolution of the rank differences between boys and girls for the eight math exercises included in at least two separate assessments. For seven of the eight exercises, the advantage for boys is very small at the start of Grade 1 and then increases over time. This shows that the overall drop observed for girls in math is not linked to a change in the content of the assessments, but reflects a real decline in their performance compared with boys for the same type of test.

The gaps widen more or less over time in favour of boys, depending on the exercises assessed. Thus, at the beginning of Grade 2, the advantage for boys is of 7 ranks for the exercises *Adding* or *Placing a number on a graduated line*, but only 0.3 rank for the exercise *Reproducing an assembly*. On the other hand, the exercise *Comparing numbers* is the only one for which the trend towards an increase in the gap at aggregate level is contradicted, since the advantage of 2 ranks in favour of boys already present at the beginning of Grade 1 decreases slightly to reach 1.2 ranks in the middle of Grade 1 (this exercise is not available in the Grade 2 assessment).

In French, the partial catching up of boys in the middle of Grade 1 seem to be partly linked to the introduction of new exercises measuring reading skills and cannot therefore be directly interpreted as boys gaining ground over girls. This observation, and the absence of any clear trend in French, leads us to concentrate mostly on the math assessments. We show the same type of Figure for recurring French items in appendix Figure A2.

3.4 More ground lost for girls among the best pupils

Are the differences between girls and boys greater or lesser for pupils who are having difficulty or for those who are doing better at school? To answer this question, we first compute the proportion

of girls at different levels of performance and examine how this changes from one assessment to the next (panel (a) of Figure 3). At the start of Grade 1, girls' performances are more 'centered' than boys' and girls are therefore slightly under-represented among both the worst and best pupils. The proportion of girls among the worst performers is thus lower than the proportion of girls assessed (orange line) up to the 20th percentile and from the 84th percentile upwards. From the middle of Grade 1, i.e. five months after the first assessment, the under-representation of girls among the best occurs earlier in the distribution, from the 70th percentile, while girls remain under-represented among the worst performers until the 4th percentile. The under-representation of girls among the best pupils becomes more pronounced at the end of the first year of elementary school. At the start of Grade 2, girls are under-represented in the first two percentiles of the performance distribution (the lowest-performing 2 % of pupils) but are then over-represented up to the 63rd percentile. Their representation finally decreases sharply with the level of performance at the top of the distribution, so that among the very best pupils at the start of Grade 2, fewer than 25 % are girls.

The phenomenon therefore seems to occur at the top of the distribution, but panel (a) of Figure 3 above does not make it possible to determine precisely which girls, on the basis of their performance at the start of Grade 1, are losing ground. Panel (b) presents the average change in rank in math for girls minus the same change for boys as a function of the initial level of each pupil measured at the start of Grade 1. It shows that, whatever their starting level, girls make less progress than boys with the same starting level. This difference in progress between girls and boys increases sharply with the initial level among the lowest-performing pupils and stabilises at around 6 ranks among the half of the highest-performing pupils at the start of Grade 1.

We perform the same type of analysis for French in appendix Figure A3. In terms of over/under-representation in the French distribution girls tend to be over-represented at the top and under-represented at the bottom of the distribution, but the dynamic between assessments is not as clear as is the case for math. The difference in French progress between boys and girls depending on starting French level is lower (between -1 and +1 rank) than for math. While girls initially at the bottom of the distribution appear to progress less than similar boys, at the top of the initial distribution they make more progress.

3.5 An evolution common to all social, family and territorial contexts

We now look at how the gender gap in math evolves according to different dimensions of heterogeneity related to the social and family context in which children live. This analysis is only possible for pupils entering Grade 1 in 2018, for whom we were able to obtain this information from the *Constat de rentrée en sixième* (see section 2).

Figure 4 uses families SES index (IPS), to classify pupils into four categories (very high SES, high SES, medium SES and low SES). The emergence of a rank gap in math in favour of boys does not

depend on the children's social background. The magnitude of the gap is even slightly more pronounced among pupils with a more privileged social status, which is partly linked to their better initial level in math (see Figure 3). In families with a very high SES, boys are on average 7.6 ranks ahead of girls, whereas this gap is just under 5.9 ranks in families with a low SES. Note that this finding is robust when considering each mothers and fathers' SES index separately as in appendix Figure A5.

We then examine the same gaps according to the child's family type (Figure 5), since the transmission of gender norms may be influenced by family composition. Our main finding remains that the change in the gap in ranking between boys and girls is to the disadvantage of girls, whatever their family type. The gap between boys and girls widens the most among children whose two legal representatives are of the same sex (same-sex families) (+8 ranks for boys at the start of Grade 2). Children brought up by two parents of different sexes (heteroparental families) come next. The gap is least pronounced among single-parent families (+5.3 ranks at the start of Grade 2) or when the legal guardians are not the parents (+3.3 ranks).

Figure 6 presents results according to a final dimension likely to affect differences in children's performance, namely the occupation of the child's legal representatives. Differences are measured within families where both parents have the same occupation (both parents teachers, engineers, unskilled workers, or employees). Here again, the trend in the gaps between boys and girls can be seen in families where the representatives have very different occupations, some of which are directly linked to mastery of the foundations of math: the gap at the start of Grade 2 is +6.8 ranks in families where both representatives are engineers and +7.1 ranks when both parents are teachers). The analysis for all the occupation categories of the mother or father of children is presented in appendix Figures A6 and A7: whatever the category considered, the evolution of the math gap is always to the disadvantage of girls.

Furthermore, we do not observe any major territorial difference depending on the child's department of schooling (Figure 7): girls lose on average between 2 and 7 ranks compared to boys. Nonetheless, girls appear to lose more ground on average in mainland France than in the overseas departments.

4 Main Results

Children, class and school characteristics can influence girls' lower progress in math relative to boys during Grade 1. In order to understand which factors may influence this lower relative progress, we present different regression tables, focusing on the influence of school, class and individual characteristics. In each, we progressively add controls for the pupil, class or school characteristics that are not the primary focus of the regression to limit bias as much as possible. Because family character-

istics are only available for the first cohort we primarily present results focusing on all cohorts but not controlling for these characteristics. We then add controls for family composition and family SES index using the first cohort only in empirical specifications that otherwise control for the same covariates or fixed effects (see “Cohort” indication at the top of regression tables). Likewise, because girls initially at the top seem to be losing more ground (panel (b) of Figure 3) we present results for all pupils and those initially in the top 50 % of the math distribution at the beginning of Grade 1. To ease interpretations, we center on their mean explanatory variables that are not categorical (e.g. teachers’ age). Coefficients should be interpreted accordingly (the reference group correspond to pupils whose non-categorical personal or school characteristics are average, and the average differential progress between girls and boys is provided for this group).

This approach helps us isolate the main factors (if any) associated with girls’ lower relative progress. The analysis remains descriptive and no causal statement should be made from the results.

4.1 Average ground lost by girls

First, we begin in Table 1 by examining the average ground lost by girls between Grade 1 and Grade 2 for the first cohort. In column (1) without any control variable or fixed effect, girls lose on average 6.7 percentile ranks to boys. Adding family controls in column (2) and controlling for pupils’ initial math score (at the start of Grade 1) in column (3) increases slightly the effect. When adding pupils’ initial French score, the drop increases to 9 percentile ranks (column (4)), and slightly again in columns (5) and (6) that introduce school and class fixed effects.

The same analysis can be made when focusing on the top 50 % pupils in math at the start of Grade 1, but the average number of ranks lost by girls is higher (see also panel (b) in Figure 3), reaching 10, in columns (10) to (12).

4.2 Specialization and pupils’ characteristics

Table 2 examines if girls’ lower relative progress in math varies according to pupils’ characteristics, and initial level in both subjects in particular. All models include Class*cohort*sex fixed effects so that the effects are examined beyond those of school and class characteristics on girls’ relative progress.

In the three first columns, we use all four cohorts available and examine the influence of pupils’ initial level in math and French and progress in French. The objective is to check whether girls’ lower progress could be driven by gender differences observed in French. For example, girls may progress less in math because they progress more in French. We first see that pupils who are initially better in French progress more (or regress less) in math. This is true no matter their gender, and the positive effect of the initial level in French is even slightly larger for girls, meaning that being good

in French slightly protects girls against falling behind in math. This result goes against the idea of a strong specialization, all the more that although not significant, in columns (2) and (3), when they progress in French, girls are not more likely than boys to fall behind in math. These conclusions hold when controlling for family characteristics (either using an average for both parents in column (6) or considering the father and mother separately in (7)), although then progress in French has a very small but significant additional effect for girls, and when considering only the best half of pupils in math at the beginning of Grade 1 in columns (8) to (14). Progressing more in French even has a significant protective effect for those girls. Therefore, the fact that girls lose ground in math compared to boys cannot be explained by their better average starting level in French or by their progress in this subject.

A last take-away from this Table is that being older slightly protects girls against falling behind in math, although, once again, the effect is small in magnitude. These insights are overall confirmed by a specific analysis of pupils in the top half of the math initial performance distribution (columns (8) to (14)).

4.3 More detailed effect of family characteristic

In columns (4) to (7) of Table 2, examining the role of socioeconomic background and family characteristics using the first cohort only, we see that once controls for other individual characteristics are included, parents' socioeconomic status seems to play little to no role in explaining the general ground lost by girls in math during Grade 1.

We try to challenge this conclusion in Table 3, focusing again on the first cohort and isolating parental occupations that might be the most likely to prevent girls from falling behind in math. We include teachers, professors, science professionals and engineers in these occupations and consider three cases: either the mother or the father works in one of these occupations, or both parents work in one of these occupations.. We also examine the influence of family types: single parent, same-sex parents, or other, with the baseline category being heterosexual families. We include class fixed effects in all specifications.

While the effect of socioeconomic status (SES index) continues to be very small, as expected, having parents that are scientists, teachers or engineers has a strong positive effect on pupils' progress in math in all specifications (columns (2), (4), (6) and (8)). Having both parents in those occupations even has a more positive, significant effect for girls (column (2)) that becomes stronger when including all family controls in column (4). Hence, in such families girls still fall behind boys, but less than in other families. When considering family types, and controlling for other family characteristics in column (4), the only significant additional effect for girls compared to heterosexual families is the one associated with being in a single parent family (see also figure 2). Girls in such families regress less compared to boys. Although similar in magnitude, the coefficient is not as significant when considering the best pupils in math initially in column (8). One can also note that children of both

genders in same-sex parents families progress significantly more in math compared to children in heterosexual families, whatever the initial math level.

Our conclusion remains that the impact of parents' occupations and family type I on closing the increase in the gender gap is limited. The coefficients associated with these factors are small in magnitude compared to the average drop experienced by girls in math, as indicated by the coefficient associated with being a girl.

4.4 School characteristics

Does the school context attenuate or, on the contrary, reinforce the dynamic of girls' decline in relative ranking compared with boys in math? In Table 4 we present the additional effects for girls of school characteristics, in models that include gradually more sets of controls and fixed effects. Here the reference school is public, not in a priority education network (Réseau d'éducation prioritaire), with no indication of extra religious activities, a standard pedagogy and average characteristics (as variables are centered to the mean).

In column (1), we see that girls appear to lose less ground relative to boys in priority education schools and in bigger schools. Column (2) adds school*cohort fixed effects to control for school quality, ie the average progress of pupils in math within each school (independent of their gender). In column (3) and (4), we further control for individual characteristics (age and initial level in math and French as well as their interaction with pupils' gender) and class characteristics (class size, teacher gender, peer effect variables etc. also interacted with gender). Finally, column (5) controls more finely for pupils' socioeconomic background and type of family (and their interaction with gender) using only the first cohort for which the information is available. The attenuated loss for girls in priority schools becomes smaller in magnitude but remains significant. The positive effect for girls' math progress of being in a bigger school also remains.

In all specifications, results remain broadly unchanged, also when considering pupils initially in the top half of the math distribution. However, even school characteristics that have a significant influence - in part due to our very large sample size - are only able to cancel' a small fraction of the average girls' dropout (around 7 ranks on average). The results show that girls lose ground relative to boys to a similar extent in schools that employ alternative pedagogy or teaching methods (such as Freinet or Montessori) that are usually considered more progressive and inclusive.

4.5 Class characteristics

Table 5 examines the effect of class characteristics in a similar fashion. The reference class is a single level class, taught by a female teacher and with average other characteristics. In column (2) onwards, we include class fixed effects, cohort*sex and school*cohort*sex fixed effects. The former control the average progress in math within each class, while the others hold constant the relative progress of girls versus boys within each school and cohort. This implies that the specifications in column (2) and following columns examine the relative progress of girls (versus boys) within each class relative to their relative progress within the school. Column (3) further controls for individual characteristics, and column (4) controls for pupils' socioeconomic background using the first cohort only.

Column (1), which does not include any control variable or fixed effect, shows that girls lose more ground in classes taught by a male teacher, a result that is consistent with the findings of the literature on teachers' role models. However, the significance of the effect disappears and its magnitude decreases when controls and fixed effects are included in subsequent columns. Similarly, some effects change signs between the simplest specifications and those with added controls and fixed effects. In column (1), having a girl as the initial math top performer in the class or the initial math gender gap in the class play in a negative way on girls' math progress whereas in columns (2) to (4), it has a positive impact. Surprisingly, the magnitude of the coefficient associated with the initial math gender gap in the class becomes very small once controls and fixed effects are introduced. Regarding the initial top performer effect in math, the positive effect of having a girl as the initial top performer, which is found in all specifications except the simplest one, is to be in line with the literature.

Overall, the only consistent and significant effect is that girls progress more in classes with a higher initial math level, benefitting more than boys from peers with a good initial math level. The effects of school characteristics, however, are limited in accounting for girls' lower progress in math during Grade 1.

5 Conclusion

In this paper, we analyse the emergence of the gender gap in math using French exhaustive administrative data covering four cohorts of pupils attending Grades 1 and 2 from 2018 to 2022. While there are no differences between boys and girls upon entry to school, girls lose 3 ranks compared to boys after 5 months of schooling. This gender gap persists through the first year of schooling, reaching 6 ranks at the beginning of Grade 2. The overall drop observed for girls is not linked to change in the content of the assessments, but reflects a real decline in their performance compared with boys for the same type of test.

During the Covid-19 pandemic years, pupils less attended school but this did not modify the dy-

namics observed for years outside the pandemic: the dropout of girls in math as early as five months after starting Grade 1, and its continuation until the start of Grade 2, are of a similar scale across all four cohorts studied since 2018.

We document the fact the girls are losing ground among the best pupils in maths in Grade 1. However this dynamic is not correlated with a specialisation of girls in French.

This increasing gender gap in maths is visible across every strata of society. Thanks to the richness of data we used, we were able to add a number of variables to control for potentially important drivers of school achievement. We thus find the influence of factors already identified in the literature as potential mediators (the size of the class, the gender of the teacher, the proportion of girls in the class, for example). However, this influence remains quantitatively too limited to be able to significantly counteract the fact that girls are losing ground in maths relative to boys during the first year of primary school.

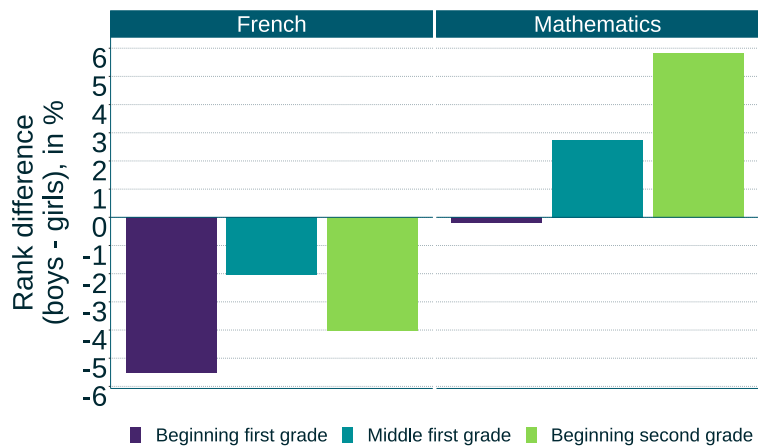
References

- BEILOCK, S. L., E. A. GUNDERSON, G. RAMIREZ, AND S. C. LEVINE (2010): "Female teachers' math anxiety affects girls' math achievement," *Proceedings of the National Academy of Sciences*, 107, 1860–1863.
- BIAN, L., S.-J. LESLIE, AND A. CIMPIAN (2017): "Gender stereotypes about intellectual ability emerge early and influence children's interests," *Science*, 355, 389–391.
- BREDA, T., J. GRENET, M. MONNET, AND C. VAN EFFENTERRE (2023): "How Effective are Female Role Models in Steering Girls Towards STEM? Evidence from French High Schools," *The Economic Journal*, 133, 1773–1809.
- BREDA, T., E. JOUINI, C. NAPP, AND G. THEBAULT (2020): "Gender stereotypes can explain the gender-equality paradox," *Proceedings of the National Academy of Sciences*, 117.
- BREDA, T. AND C. NAPP (2019): "Girls' comparative advantage in reading can largely explain the gender gap in math-related fields," *Proceedings of the National Academy of Sciences*, 116, 15435–15440.
- BRENØE, A. A. AND U. ZÖLITZ (2020): "Exposure to more female peers widens the gender gap in STEM participation," *Journal of Labor Economics*, 38, 1009–1054.
- CARD, D. AND A. A. PAYNE (2021): "High school choices and the gender gap in STEM," *Economic Inquiry*, 59, 9–28.
- CARLANA, M. (2019): "Implicit stereotypes: Evidence from teachers' gender bias," *The Quarterly Journal of Economics*, 134, 1163–1224.
- COBB-CLARK, D. A. AND J. MOSCHION (2017): "Gender gaps in early educational achievement," *Journal of Population Economics*, 30, 1093–1134.
- DEE, T. S. (2005): "A teacher like me: Does race, ethnicity, or gender matter?" *American Economic Review*, 95, 158–165.
- (2007): "Teachers and the gender gaps in student achievement," *Journal of Human resources*, 42, 528–554.
- DEPP (2023): "Filles et garçons sur le chemin de l'égalité. De l'école à l'enseignement supérieur," Tech. rep., DEPP.
- DURU-BELLAT, M. (2008): "La (re) production des rapports sociaux de sexe: quelle place pour l'institution scolaire?" *Travail! genre et sociétés*, 131–149.
- (2016): "À l'école du genre," *Enfances & Psy*, 90–100.
- FISCHER, J.-P. AND X. THIERRY (2022): "Boy's math performance, compared to girls', jumps at age 6 (in the ELFE's data at least)," *British Journal of Developmental Psychology*, 40, 504–519.
- FRYER JR, R. G. AND S. D. LEVITT (2010): "An empirical analysis of the gender gap in mathematics," *American Economic Journal: Applied Economics*, 2, 210–240.
- LAVY, V. AND E. SAND (2018): "On the origins of gender gaps in human capital: Short-and long-term consequences of teachers' biases," *Journal of Public Economics*, 167, 263–279.

- MARTINOT, P., S. DEHAENE, P. BRESSOUX, P. HUGUET, C. POTIER-WATKINS, L. SPRENGER-CHAROLLES, AND J. ZIEGLER (2021): "Qu'apprend-on des évaluations de CP-CE1?" Tech. rep., CSEN.
- NAPP, C. AND T. BREDI (2022): "The stereotype that girls lack talent: A worldwide investigation," *Science Advances*, 8, eabm3689.
- PAREDES, V. (2022): "Mixed but not scrambled: Gender gaps in coed schools with single-sex classrooms," *Journal of Research on Educational Effectiveness*, 15, 330–366.
- PENNER, A. M. AND M. PARET (2008): "Gender differences in mathematics achievement: Exploring the early grades and the extremes," *Social Science Research*, 37, 239–253.
- TERRIER, C. (2020): "Boys lag behind: How teachers' gender biases affect student achievement," *Economics of Education Review*, 77, 101981.

6 Figures and Tables

Figure 1: Gender gaps over time

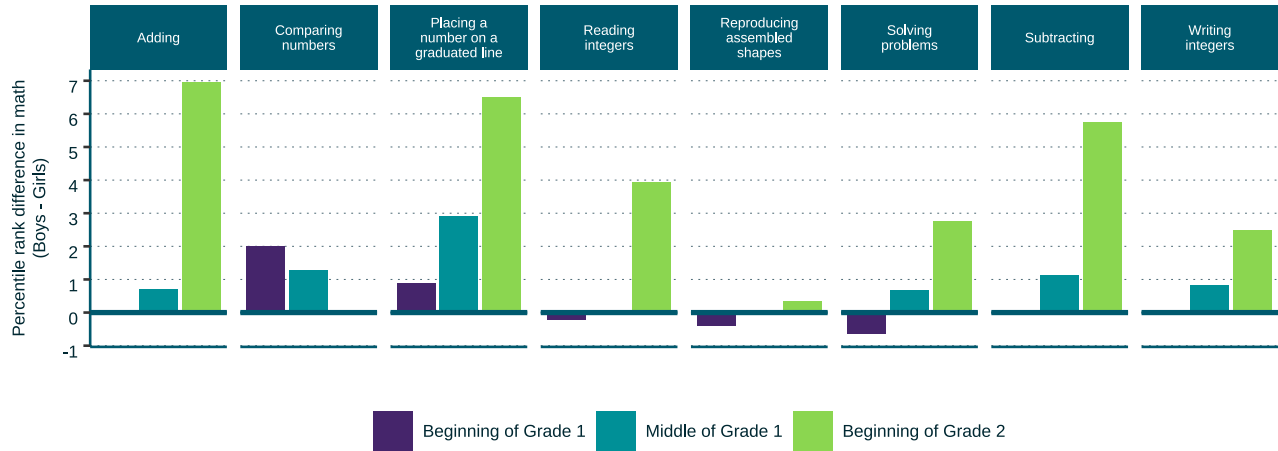


Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

Figure 2: Gender gaps for recurring Mathematics items

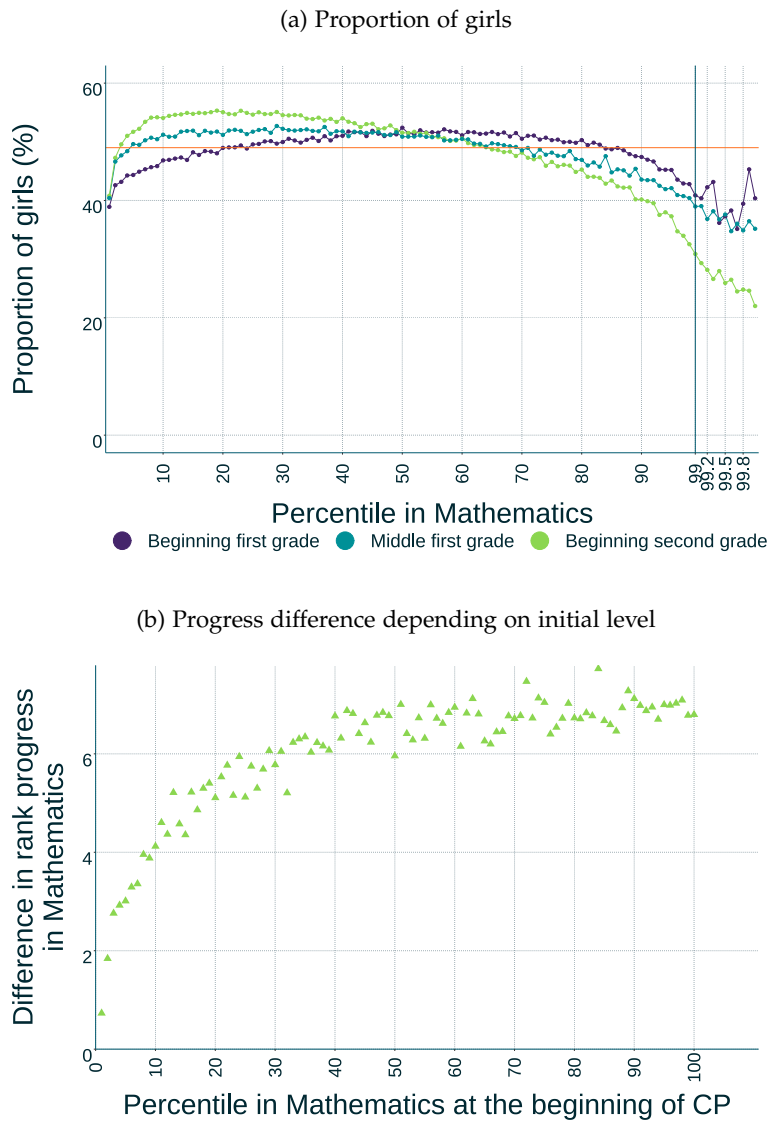


Notes: A positive gap means that boys outperform girls and *vice versa*. Items presented are those that are evaluated in more than one assessment (per cohort). The item *Placing a number on a graduated line* actually pools together the results of two similar items (*Placing a number on a graduated line* or *numerical line*).

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

Figure 3: Gender gap dynamics in the Mathematics distribution

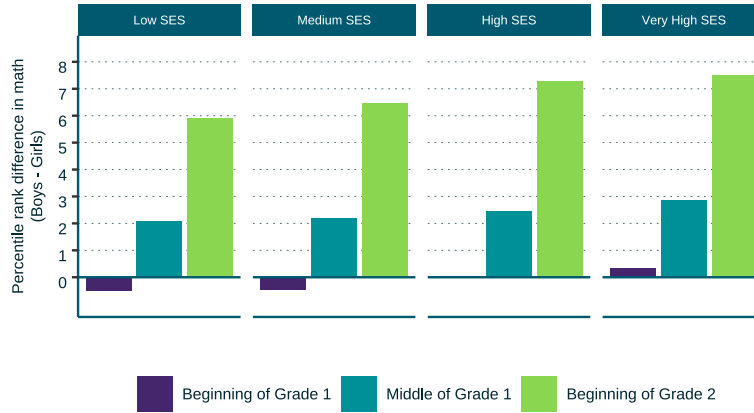


Notes: We rank student by score percentile from the smallest (the 1 % with the worst results) to the highest (the 1 % with the best results). Figure a) also includes a focus on the top 1 % of students. In figure b) the initial Mathematics percentile (x-axis) is defined relatively to the beginning of Grade 1 evaluation.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

Figure 4: Gender gap in math by family SES index

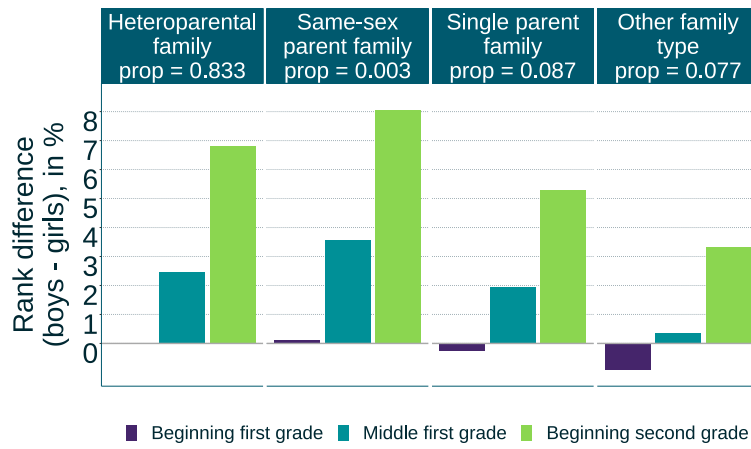


Notes: A positive gap means that boys outperform girls and *vice versa*. The proportion of the sample within each category is indicated. When it does not add up to 1, it means that some categories (including missing observations) are not shown.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure 5: Gender gap in math by family type

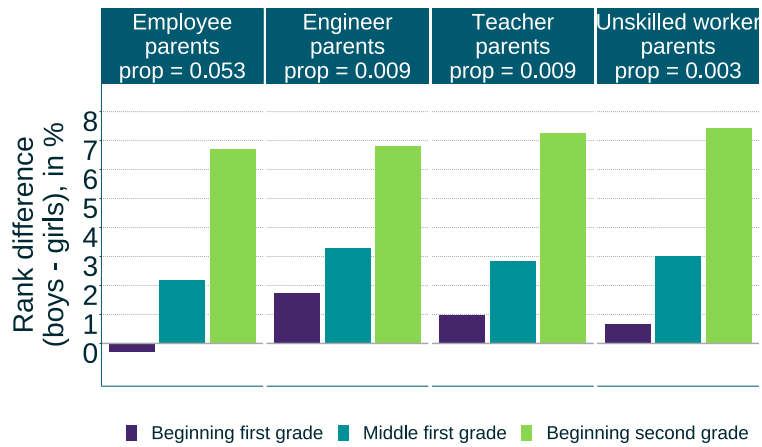


Notes: A positive gap means that boys outperform girls and *vice versa*. The proportion of the sample within each category is indicated. When it does not add up to 1, it means that some categories (including missing observations) are not shown.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure 6: Gender gap in math by parents' occupation

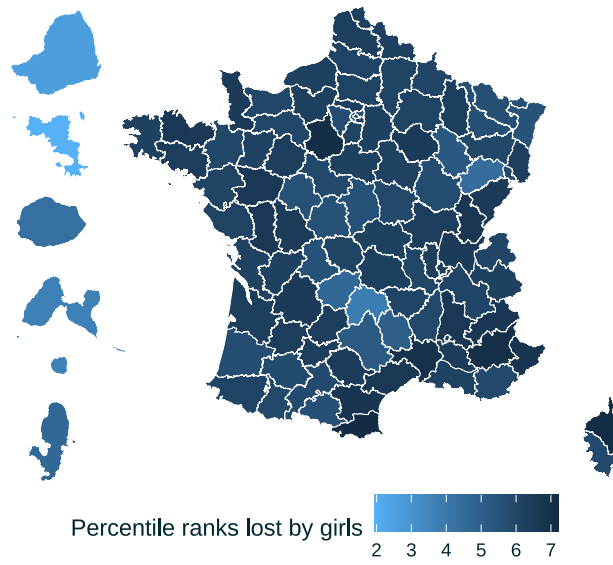


Notes: A positive gap means that boys outperform girls and *vice versa*. The proportion of the sample within each category is indicated. When it does not add up to 1, it means that some categories (including missing observations) are not shown.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure 7: Ranks lost by girls depending on departement



Notes: Overseas departments (not true to scale) are placed on the left of mainland France.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1 & APAE1D; Authors' computations.

Table 1: Effect of gender and controls on math progress

Dependent Variable: Mathematics initial level	Mathematics progress											
	all students					top 50%						
						first cohort						
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>Variables</i>												
Constant	3.535*** (0.0784)	1.351** (0.5639)	5.123*** (0.5121)	4.641*** (0.4839)			-5.156*** (0.0926)	-4.954*** (0.7168)	8.193*** (0.6944)	7.166*** (0.6588)		
girl	-6.725*** (0.0652)	-6.992*** (0.0675)	-6.871*** (0.0611)	-9.046*** (0.0591)	-9.242*** (0.0557)	-9.330*** (0.0565)	-7.408*** (0.0885)	-7.437*** (0.0884)	-8.068*** (0.0849)	-10.20*** (0.0816)	-10.19*** (0.0786)	-10.19*** (0.0880)
age		-0.5173*** (0.0119)	-0.1657*** (0.0104)	-0.2296*** (0.0100)	-0.2913*** (0.0096)	-0.3202*** (0.0097)		-0.1490*** (0.0163)	0.0408** (0.0160)	-0.0654*** (0.0150)	-0.1781*** (0.0144)	-0.2196*** (0.0162)
SES index family		-0.0089*** (0.0026)	-0.0144*** (0.0024)	-0.0115*** (0.0022)	-0.0052*** (0.0019)	-0.0040** (0.0020)		-0.0121*** (0.0035)	-0.0101*** (0.0034)	-0.0087*** (0.0032)	-0.0059** (0.0029)	-0.0043 (0.0033)
family type: other family type		-2.006*** (0.7002)	-4.637*** (0.6420)	-3.834*** (0.6131)	-1.819*** (0.5451)	-1.473*** (0.5451)		-3.129** (1.331)	-4.180*** (1.268)	-3.457*** (1.203)	-1.052 (1.035)	-0.6461 (1.131)
family type: single parent family		-0.9649*** (0.1829)	-1.243*** (0.1681)	-1.219*** (0.1565)	-0.5900*** (0.1318)	-0.5488*** (0.1343)		-1.088*** (0.2658)	-1.020*** (0.2523)	-0.9687*** (0.2381)	-0.4749** (0.2160)	-0.3600 (0.2436)
family type: same-sex parent family		0.9199 (0.6361)	3.004*** (0.5597)	1.623*** (0.5266)	1.929*** (0.4884)	1.884*** (0.5038)		1.751** (0.7875)	2.557*** (0.7490)	1.224* (0.7091)	1.193* (0.6585)	1.391* (0.7533)
initial maths score			-0.4309*** (0.0015)	-0.6496*** (0.0018)	-0.6287*** (0.0015)	-0.6149*** (0.0015)			-0.5041*** (0.0034)	-0.6813*** (0.0035)	-0.6082*** (0.0031)	-0.5804*** (0.0034)
initial french score				0.3679*** (0.0018)	0.4051*** (0.0016)	0.4160*** (0.0015)				0.3533*** (0.0024)	0.3908*** (0.0021)	0.4028*** (0.0023)
<i>Controls</i>												
Parents' professions		Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Girl x Parents' professions		Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes
<i>Fixed-effects</i>												
school_id					Yes	Yes					Yes	Yes
classroom_id						Yes						Yes
<i>Fit statistics</i>												
Observations	616,233	580,513	580,513	566,194	566,194	537,876	308,367	298,943	298,943	292,999	292,999	278,336
R ²	0.01780	0.02675	0.23091	0.31968	0.45092	0.49315	0.02309	0.04827	0.14006	0.23366	0.42158	0.48488
Within R ²					0.31857	0.31098					0.22822	0.22543
Adjusted R ²	0.01779	0.02660	0.23079	0.31957	0.42257	0.41697	0.02309	0.04800	0.13981	0.23343	0.36221	0.31755
Within Adjusted R ²					0.31846	0.31085					0.22796	0.22510

Clustered (cohort-school_id) standard-errors in parentheses
 Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: Mathematics' progress is the difference in percentile rank between the start of Grade 2 and the start of Grade 1. The set of controls "Parents' occupations" refer to mother and father occupation code (PCS, see Section 2). When school fixed effects are included we introduce school dummies in the regression, likewise for class fixed effects. All continuous explanatory variables are centered to the mean.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1 & APAE1D; Authors' computations.

Table 2: Specialization, family characteristics and girls' mathematics progress

Dependent Variable: Mathematics initial level	Mathematics progress													
	all students						top 50%							
	all cohorts		first cohort				all cohorts		first cohort					
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
<i>Variables</i>														
age	-0.4410*** (0.0064)	-0.3544*** (0.0065)	-0.2316*** (0.0054)					-0.2175*** (0.0118)	-0.2157*** (0.0118)	-0.3422*** (0.0097)	-0.2581*** (0.0099)	-0.1750*** (0.0085)		
initial maths score	-0.5664*** (0.0010)	-0.2984*** (0.0007)	-0.6286*** (0.0009)					-0.6359*** (0.0020)	-0.6368*** (0.0020)	-0.5648*** (0.0020)	-0.3453*** (0.0020)	-0.6213*** (0.0019)		
initial french score	0.3895*** (0.0010)		0.5445*** (0.0010)					0.5735*** (0.0022)	0.5711*** (0.0022)	0.3543*** (0.0014)		0.4960*** (0.0015)		
girl × age	0.1714*** (0.0089)	0.2219*** (0.0090)	0.1528*** (0.0076)					0.1782*** (0.0165)	0.1766*** (0.0165)	0.1674*** (0.0137)	0.2728*** (0.0142)	0.1580*** (0.0120)		
girl × initial maths score	-0.0598*** (0.0013)	-0.0355*** (0.0010)	-0.0594*** (0.0013)					-0.0673*** (0.0028)	-0.0667*** (0.0028)	-0.0209*** (0.0029)	-0.0034 (0.0029)	-0.0248*** (0.0028)		
girl × initial french score	0.0304*** (0.0014)		0.0305*** (0.0014)					0.0131*** (0.0030)	0.0146*** (0.0030)	0.0798*** (0.0021)		0.0982*** (0.0021)		
progress in french		0.1996*** (0.0010)	0.3858*** (0.0010)					0.3693*** (0.0022)	0.3677*** (0.0022)		0.1587*** (0.0014)	0.3398*** (0.0014)		
girl × progress in french		-0.0019 (0.0014)	-0.0006 (0.0013)					-0.0082*** (0.0029)	-0.0072** (0.0029)		0.0285*** (0.0020)	0.0431*** (0.0020)		
SES index family				0.0226*** (0.0009)		0.0161*** (0.0007)						0.0342*** (0.0013)		0.0106*** (0.0011)
girl × SES index family				-0.0097*** (0.0012)		-0.0045*** (0.0010)						0.0012 (0.0018)		0.0011 (0.0015)
SES index mother					0.0130*** (0.0012)		0.0062*** (0.0010)						0.0216*** (0.0017)	0.0030** (0.0014)
SES index father					0.0199*** (0.0011)		0.0189*** (0.0009)						0.0278*** (0.0016)	0.0124*** (0.0013)
girl × SES index mother					-0.0088*** (0.0016)		-0.0047*** (0.0013)						-0.0031 (0.0024)	-0.0018 (0.0020)
girl × SES index father					-0.0065*** (0.0015)		-0.0046*** (0.0013)						0.0038* (0.0022)	0.0018 (0.0019)
<i>Fixed-effects</i>														
cohort-classroom_id-sex	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>														
Observations	2,653,589	2,620,218	2,620,218	584,195	584,195	564,159	564,159	1,370,207	1,356,968	1,356,968	292,484	292,484	284,674	284,674
R ²	0.50597	0.45047	0.58366	0.33316	0.33350	0.59226	0.59261	0.53133	0.47608	0.59721	0.45042	0.45089	0.61559	0.61570
Within R ²	0.28047	0.19758	0.39206	0.00181	0.00232	0.38575	0.38628	0.18963	0.09154	0.30157	0.00707	0.00791	0.30026	0.30046
Adjusted R ²	0.41710	0.35022	0.50771	0.21809	0.21848	0.51932	0.51973	0.35870	0.28115	0.44735	0.25013	0.25075	0.47186	0.47201
Within Adjusted R ²	0.28047	0.19758	0.39206	0.00181	0.00231	0.38574	0.38626	0.18962	0.09153	0.30157	0.00706	0.00789	0.30022	0.30042

Clustered (cohort-school_id) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: Mathematics' progress is the difference in percentile rank between the start of Grade 2 and the start of Grade 1. For more details on the SES index for parents or family see Section 2. For the fixed effects, each specification includes dummies for every combination of cohort*class*gender possible. All continuous explanatory variables are centered to the mean.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1 & APAE1D; Authors' computations.

Table 3: More detailed effect of family composition on girls' mathematics' progress

Dependent Variable: Mathematics initial level	Mathematics progress							
	all students			first cohort		top 50%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
girl	-7.378*** (0.2823)	-6.897*** (0.0701)	-7.005*** (0.0682)	-7.285*** (0.3650)	-7.594*** (0.3986)	-7.399*** (0.0990)	-7.295*** (0.0918)	-8.100*** (0.5186)
SES index mother	0.0203*** (0.0018)			0.0108*** (0.0024)	0.0221*** (0.0028)			0.0301*** (0.0035)
SES index father	0.0286*** (0.0020)			0.0206*** (0.0025)	0.0272*** (0.0029)			0.0375*** (0.0035)
SES index family	-0.0122*** (0.0025)			-0.0048 (0.0033)	0.0003 (0.0036)			-0.0102** (0.0046)
girl × SES index mother	-0.0142*** (0.0025)			-0.0104*** (0.0033)	-0.0045 (0.0038)			-0.0075 (0.0047)
girl × SES index father	-0.0143*** (0.0027)			-0.0098*** (0.0035)	0.0006 (0.0040)			-0.0028 (0.0049)
girl × SES index family	0.0093*** (0.0035)			0.0046 (0.0045)	0.0041 (0.0050)			0.0084 (0.0064)
scient./prof./engineer mother		2.268*** (0.2114)		1.417*** (0.2267)		3.860*** (0.2360)		2.045*** (0.2575)
scient./prof./engineer father		1.975** (0.1777)		0.6897*** (0.1948)		3.633*** (0.2021)		1.608*** (0.2251)
scient./prof./engineer parents		2.683*** (0.2641)		1.016*** (0.2807)		5.155*** (0.2854)		2.054*** (0.3099)
girl × scient./prof./engineer mother		-0.1783 (0.2959)		0.5534* (0.3193)		0.2334 (0.3383)		0.3731 (0.3691)
girl × scient./prof./engineer father		-0.0265 (0.2514)		0.6560** (0.2771)		0.5617* (0.2923)		0.4206 (0.3282)
girl × scient./prof./engineer parents		0.8882** (0.3752)		1.979*** (0.4022)		1.543*** (0.4013)		1.519*** (0.4404)
family type: other family type			-3.089*** (0.8678)	-0.3913 (0.8888)			-2.979* (1.626)	3.450** (1.653)
family type: single parent family			-1.615*** (0.1605)	-0.1760 (0.2022)			-2.073*** (0.2502)	0.9258*** (0.3188)
family type: same-sex parent family			1.999** (0.8378)	3.094*** (0.8482)			1.853* (1.047)	4.352*** (1.064)
girl × family type: other family type			3.326*** (1.175)	1.862 (1.204)			-0.7993 (2.226)	-1.060 (2.266)
girl × family type: single parent family			1.332*** (0.2201)	0.7796*** (0.2773)			0.3553 (0.3398)	0.7754* (0.4389)
girl × family type: same-sex parent family			-1.556 (1.187)	-1.934 (1.202)			-2.155 (1.515)	-1.631 (1.534)
<i>Fixed-effects</i>								
cohort-classroom_id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	584,195	550,757	550,757	550,757	292,484	283,698	283,698	283,698
R ²	0.27504	0.28102	0.28030	0.28162	0.35493	0.35682	0.35296	0.35998
Within R ²	0.02484	0.02455	0.02358	0.02536	0.03648	0.03550	0.02971	0.04023
Adjusted R ²	0.21647	0.21917	0.21840	0.21981	0.24602	0.24462	0.24008	0.24829
Within Adjusted R ²	0.02483	0.02453	0.02357	0.02533	0.03645	0.03547	0.02968	0.04016

Clustered (cohort-school_id) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: Mathematics' progress is the difference in percentile rank between the start of Grade 2 and the start of Grade 1. For more details on the SES index for parents or family see Section 2. For the fixed effects, each specification includes dummies for every combination of cohort*class*gender possible. All continuous explanatory variables are centered to the mean.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1, APAE1D & Constats de rentrée en sixième; Authors' computations.

Table 4: School characteristics and girls' mathematics progress

Dependent Variable: Mathematics initial level	Mathematics progress									
	all students				top 50%					
	all cohorts				first cohort	all cohorts				first cohort
Cohort	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Variables</i>										
girl × school type: Public-priority	0.8487*** (0.1109)	0.7817*** (0.1061)	0.7444*** (0.0861)	0.4042*** (0.1042)	0.4892** (0.2457)	1.057*** (0.1706)	1.030*** (0.1679)	0.9504*** (0.1412)	0.6360*** (0.1625)	0.4821 (0.3926)
girl × school type: Public-priority+	1.064*** (0.1429)	1.133*** (0.1368)	1.194*** (0.1136)	0.9043*** (0.1281)	0.7487** (0.3063)	0.9657*** (0.2409)	1.323*** (0.2333)	1.432*** (0.1997)	1.179*** (0.2159)	1.161** (0.5209)
girl × school type: Private	0.2397 (0.1493)	0.0730 (0.1413)	0.1315 (0.1099)	0.0838 (0.1122)	0.3939 (0.2834)	0.0723 (0.1761)	0.0190 (0.1691)	0.1467 (0.1442)	0.1261 (0.1480)	0.4136 (0.3779)
girl × school size	0.0748*** (0.0280)	0.0906*** (0.0270)	0.1614*** (0.0220)	0.1903*** (0.0246)	0.2534*** (0.0578)	0.0464 (0.0362)	0.0642* (0.0353)	0.1057*** (0.0299)	0.1203*** (0.0330)	0.2238*** (0.0833)
girl × school SES index	0.0043* (0.0023)	0.0045** (0.0022)	-0.0077*** (0.0018)	-0.0148*** (0.0019)	-0.0257*** (0.0046)	0.0246*** (0.0030)	0.0232*** (0.0029)	-0.0026 (0.0025)	-0.0069** (0.0027)	-0.0243*** (0.0065)
girl × school pedagogy: alternative	-0.6918 (1.086)	-0.9306 (1.096)	-1.104 (0.8036)	-1.070 (0.8098)	0.3334 (2.054)	-2.009 (1.616)	-1.995 (1.630)	-1.792 (1.168)	-1.839 (1.164)	-1.190 (3.376)
girl × school religion: yes	-0.2282 (0.1777)	-0.0848 (0.1676)	-0.1609 (0.1308)	-0.1544 (0.1314)	-0.4125 (0.3332)	0.0108 (0.2071)	0.0410 (0.1990)	-0.1290 (0.1697)	-0.0989 (0.1710)	-0.4634 (0.4371)
<i>Controls</i>										
Individual			Yes	Yes	Yes			Yes	Yes	Yes
Family					Yes					Yes
Class				Yes	Yes				Yes	Yes
<i>Fixed-effects</i>										
cohort-school_id		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
cohort-sex		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
<i>Fit statistics</i>										
Observations	2,584,138	2,584,138	2,502,114	2,455,162	498,506	1,321,418	1,321,418	1,290,004	1,264,628	256,800
R ²	0.02025	0.17910	0.51319	0.51485	0.52751	0.02792	0.22853	0.47227	0.47386	0.49589
Within R ²		5.75 × 10 ⁻⁵	0.40585	0.40883	0.40534		0.00013	0.31446	0.31820	0.31588
Adjusted R ²	0.02025	0.14208	0.49052	0.49263	0.50379	0.02791	0.15855	0.42325	0.42564	0.44526
Within Adjusted R ²		5.39 × 10 ⁻⁵	0.40585	0.40882	0.40509		0.00012	0.31445	0.31818	0.31528

Clustered (cohort-school_id) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: Mathematics' progress is the difference in percentile rank between the start of Grade 2 and the start of Grade 1. Controls are included both individually and interacted with gender. Individual controls include: pupils' age (in months) their initial math and French score (beginning of Grade 1) and progress in French between the beginning of Grade 1 and Grade 2; class controls include: the gender of teacher (female as baseline), class size, whether the class is simple or multilevel (simple level as baseline), the proportion of girls, the class initial math level (at beginning of Grade 1), math gender gap (boys - girls) and gender of top performers; family controls include: the family SES index (IPS), occupations (PCS) of parents and type of family (heterosexual, same-sex, single parent, other). All continuous explanatory variables are centered to the mean. For fixed effects, we include dummies for each cohort*school and cohort*sex.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1, APAE1D & Constats de rentrée en sixième; Authors' computations.

Table 5: Class characteristics and girls' mathematics progress

Dependent Variable: Mathematics initial level	Mathematics progress							
	all students			top 50%				
	all cohorts			first cohort	all cohorts			first cohort
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
girl × class size	-0.0715*** (0.0062)	0.0064 (0.0162)	-0.0195 (0.0134)	-0.0093 (0.0300)	-0.0302*** (0.0083)	0.0067 (0.0223)	-0.0160 (0.0197)	-0.0146 (0.0450)
girl × class girls proportion	4.152*** (0.3012)	0.1241 (0.5295)	0.2282 (0.4556)	-0.7031 (1.093)	2.682*** (0.3889)	1.182 (0.8207)	0.5548 (0.7226)	0.6922 (1.739)
girl × class multilevel: yes	-0.8211*** (0.0881)	4.952*** (1.845)	3.386** (1.622)	-2.749 (3.428)	-0.5325*** (0.1195)	5.693** (2.581)	3.693 (2.677)	1.898 (4.916)
girl × class multilevel: unknown	-0.1574** (0.0758)	5.559*** (1.853)	3.988** (1.628)	-2.363 (3.443)	-0.1889* (0.1012)	6.005** (2.590)	4.006 (2.686)	2.468 (4.927)
girl × teacher gender: male	-0.7626*** (0.1776)	-0.4972** (0.2361)	-0.0844 (0.2021)	0.2771 (0.4482)	-0.4337* (0.2393)	-0.4296 (0.3693)	-0.0547 (0.3236)	0.0493 (0.7444)
girl × teacher gender: unknown	0.0677 (0.0663)	-0.2486 (0.2876)	-0.2308 (0.2528)	0.0087 (0.5635)	0.0299 (0.0875)	-0.1790 (0.4382)	-0.2025 (0.3918)	-0.3927 (0.8839)
girl × class initial maths level	0.0082*** (0.0022)	0.0044 (0.0040)	0.0322*** (0.0036)	0.0342*** (0.0082)	0.0251*** (0.0030)	0.0093 (0.0066)	0.0113* (0.0064)	0.0132 (0.0147)
girl × class initial maths top performer: girl	-4.580*** (0.0669)	0.1159 (0.0922)	0.3301*** (0.0789)	0.5834*** (0.1883)	-3.258*** (0.0856)	0.0676 (0.1360)	0.2770** (0.1189)	0.5361* (0.2801)
girl × class initial maths gender gap	-0.0653*** (0.0023)	0.0169*** (0.0031)	0.0086*** (0.0025)	0.0161*** (0.0061)	-0.0474*** (0.0029)	0.0080* (0.0047)	-0.0013 (0.0041)	0.0041 (0.0100)
<i>Controls</i>								
Individual			Yes	Yes			Yes	Yes
Family				Yes				Yes
<i>Fixed-effects</i>								
cohort-classroom_id		Yes	Yes	Yes		Yes	Yes	Yes
cohort-sex		Yes	Yes	Yes		Yes	Yes	Yes
cohort-school_id-sex		Yes	Yes	Yes		Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	2,683,145	2,683,145	2,599,464	528,560	1,376,676	1,376,676	1,344,476	273,703
R ²	0.04891	0.36961	0.56639	0.58104	0.03060	0.40747	0.56912	0.59198
Within R ²		0.12012	0.39180	0.38478		0.04452	0.30087	0.29675
Adjusted R ²	0.04890	0.24891	0.48030	0.49152	0.03059	0.14943	0.37585	0.39412
Within Adjusted R ²		0.12012	0.39179	0.38452		0.04451	0.30085	0.29603

Clustered (cohort-school_id) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: Mathematics' progress is the difference in percentile rank between the start of Grade 2 and the start of Grade 1. The class initial math level and gender gap (boys - girls) variables are computed for each pupil by excluding their own observation. Controls are included both individually and interacted with gender. Individual controls include: pupils' age (in months) their initial math and French score (beginning of Grade 1) and progress in French between the beginning of Grade 1 and Grade 2; family controls include: the family SES index (IPS), occupations (PCS) of parents and type of family (heterosexual, single sex, single parent, other). In all specifications, we control for whether the class is single or multilevel and interactions with gender. All continuous explanatory variables are centered to the mean. For fixed effects we include dummies for each class, cohort*sex groups, and cohort*school*sex groups.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1, APAE1D & Constats de rentrée en sixième; Authors' computations.

A Appendix

A.1 Descriptive statistics

Table A1: Score distribution statistics by gender

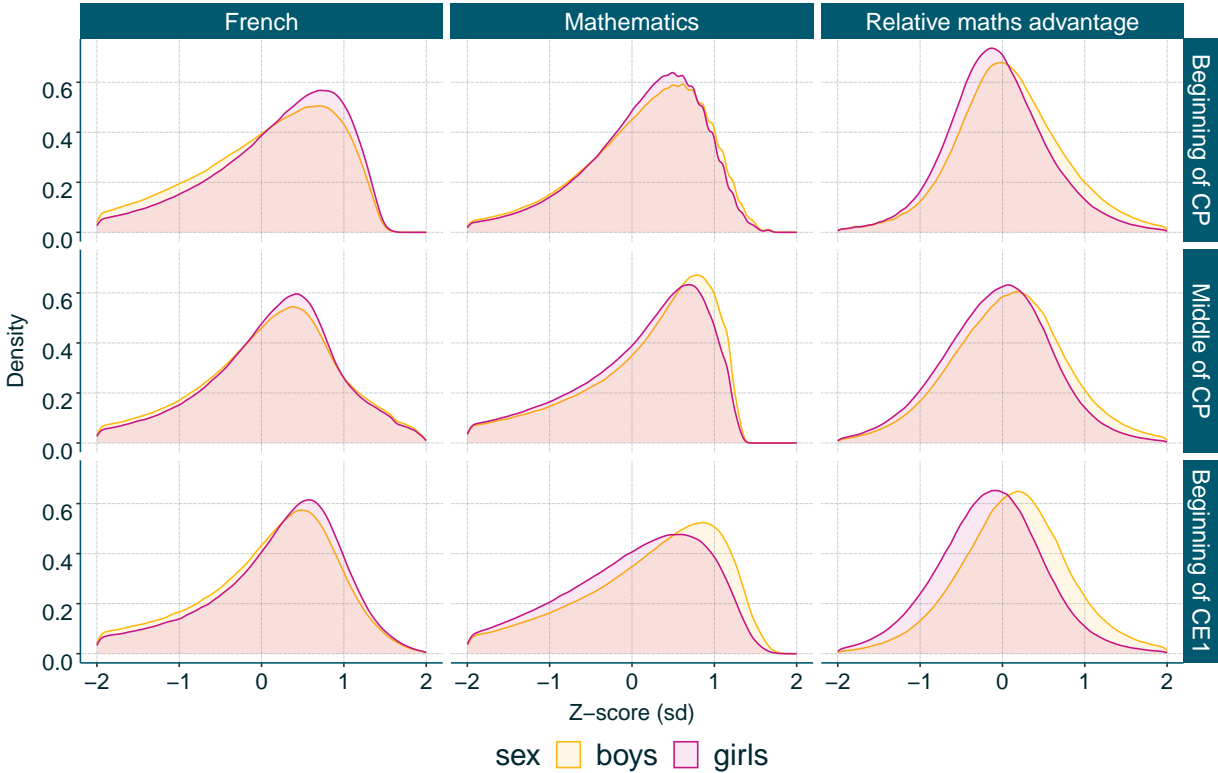
	French						Mathematics					
	Beginning first grade		Middle first grade		Beginning second grade		Beginning first grade		Middle first grade		Beginning second grade	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Mean	47.3	52.81	49	51.04	48.03	52.05	49.9	50.1	51.34	48.59	52.86	47.03
Min	0	0	0	0	0	0	0	0	0	0	0	0
Max	99.99	99.99	99.99	99.99	100	100	99.93	99.93	99.79	99.79	99.99	99.99
SD	29.02	28.44	29.44	28.22	28.91	28.68	29.56	28.12	29.42	28.19	29.57	27.81
Q10	8.3	12.39	8.72	11.54	8.82	11.46	9.1	11.01	9.9	10.1	10.39	9.67
Q25	21.75	28.85	23.11	27.02	22.83	27.49	23.85	26.16	25.71	24.34	27.32	23.09
Q75	72.21	77.52	74.76	75.22	72.73	77.05	75.95	74.06	77.32	72.47	79.1	70.24
Q90	88.61	91.16	90.27	89.71	89.04	90.82	90.94	88.93	91.38	88.21	92.31	86.58
N	1,505,905	1,445,479	1,452,264	1,394,757	1,575,751	1,519,479	1,522,404	1,459,807	1,466,644	1,407,820	1,580,993	1,522,964
Prop. NA	0.13	0.12	0.16	0.15	0.09	0.08	0.12	0.11	0.15	0.15	0.09	0.08

Notes: Statistics are expressed in percentile ranks.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

Figure A1: Densities by gender

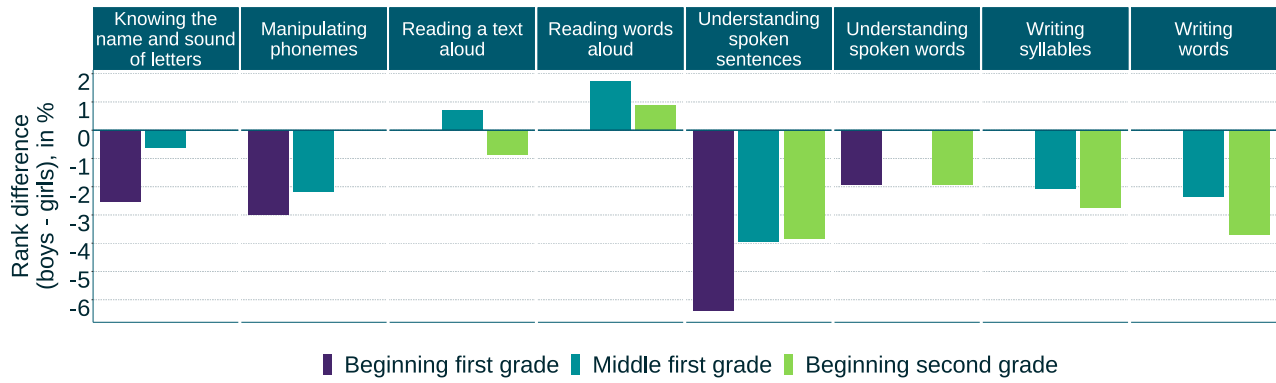


Notes: Gender densities shown use Z-scores, and not corresponding percentile ranks. The relative Mathematics advantage is for a given student and assessment the difference between her Mathematics and French Z-score.
 Sample: Students in Grade 1 between 2018 and 2022.
 Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

A.2 Supplementary results

A.2.1 French

Figure A2: Gender gaps for recurring French items

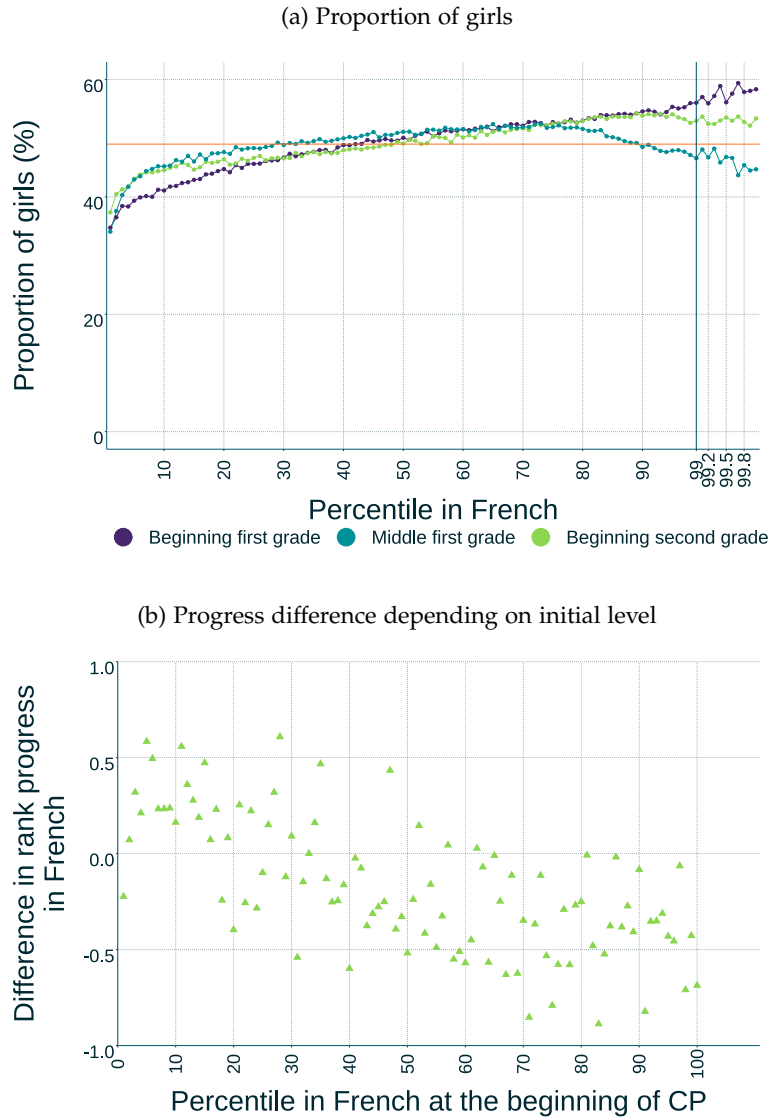


Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

Figure A3: Gender gap dynamics in the French distribution



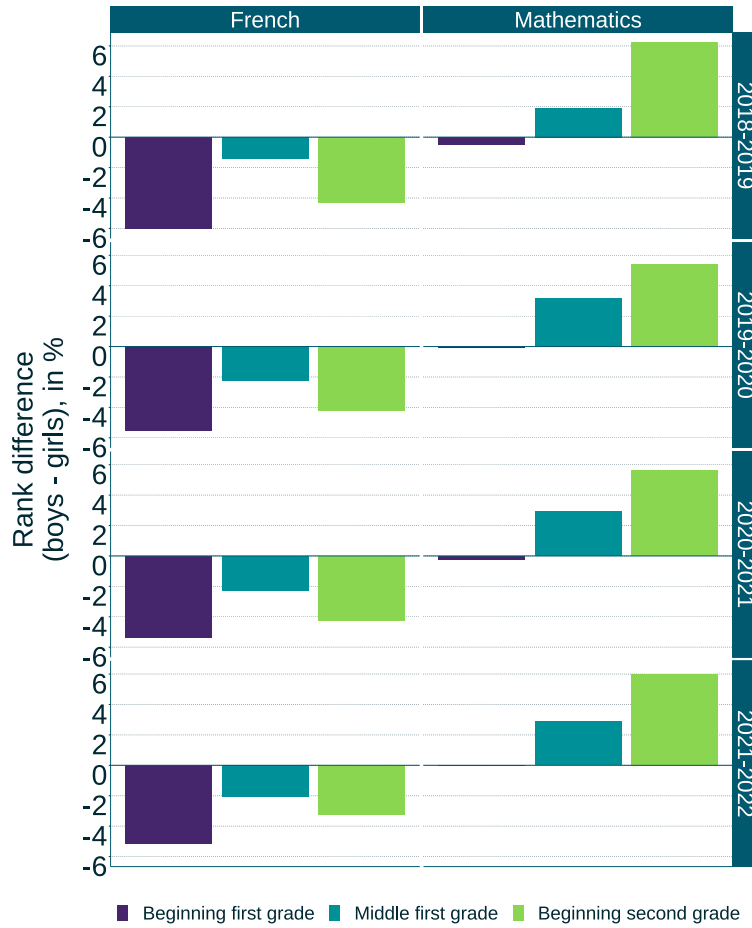
Notes: We rank student by score percentile from the smallest (the 1 % with the worst results) to the highest (the 1 % with the best results). Figure a) also includes a focus on the top 1 % of students. In figure b) the initial French percentile (x-axis) is defined relatively to the beginning of CP evaluation.

Sample: Students in Grade 1 between 2018 and 2022.

Sources: MENJ-DEPP, Repères CP-CE1; Authors' computations.

A.2.2 Gender gaps

Figure A4: Gender gaps for each cohort



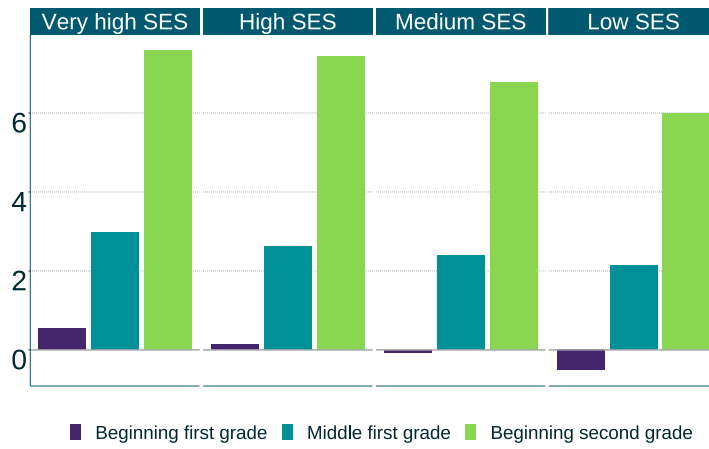
Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 between 2018 and 2022.

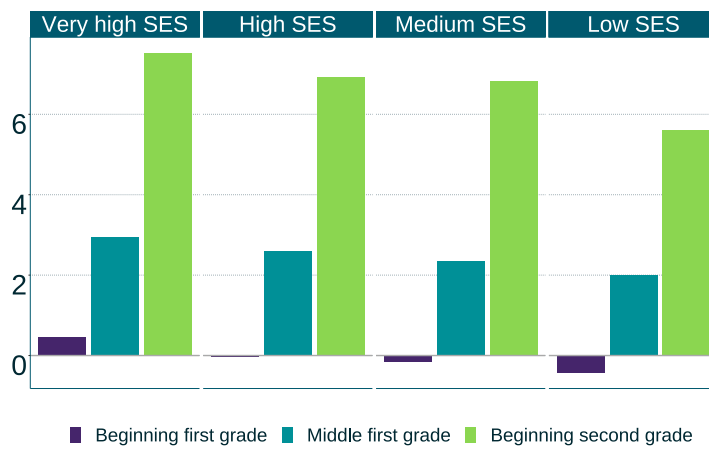
Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure A5: Mathematics gender gaps depending on parents' SES index

(a) Father SES index



(b) Mother SES index



Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure A6: Mathematics gender gaps and mother's occupation

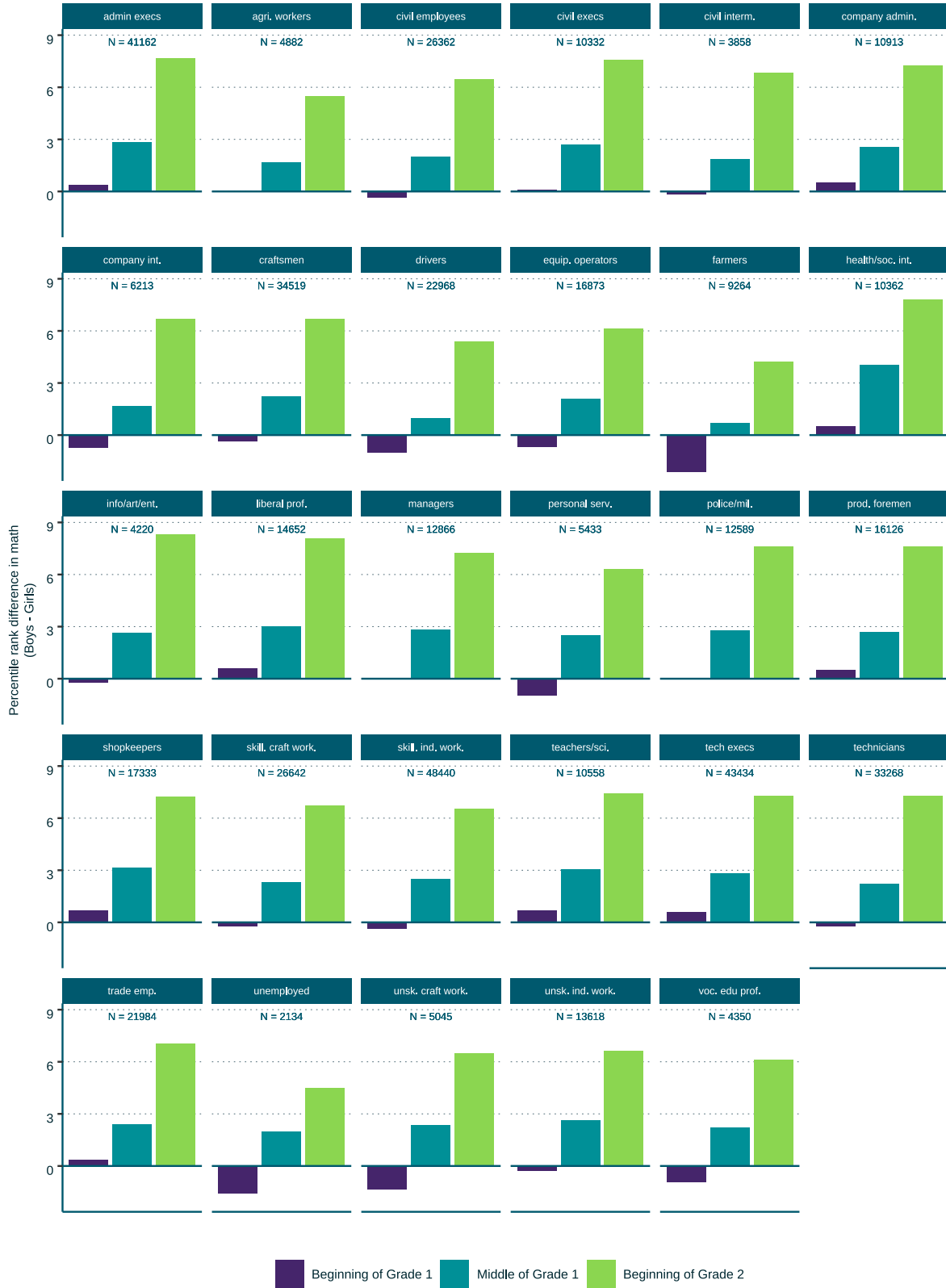


Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.

Figure A7: Mathematics gender gaps and father's occupation



Notes: A positive gap means that boys outperform girls and *vice versa*.

Sample: Students in Grade 1 in 2018-2019.

Sources: MENJ-DEPP, Repères CP-CE1 & Constats de rentrée en sixième; Authors' computations.