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Predictors of the IQ-achievement gap in France: A longitudinal analysis

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ABSTRACT

Why do some children under-perform at school relative to their level of cognitive abilities? So far, previous studies on the topic have been conducted on cross-sectional data or have focused on a limited range of predictors. In this large longitudinal study on 23,258 French middle school students, we examined the relative effects of a wide range of contextual and individual factors on academic performance beyond the effect of non-verbal IQ. Data were analyzed using a structural equation modeling approach, cross-sectionally and longitudinally. Cross-sectional models revealed that self-efficacy, school environment, parental education and sex were the most predictive factors of achievement independently from non-verbal IQ (the latter being by far the best predictor). A longitudinal analysis showed that school environment and parental education also significantly affected progression between grade 6 (11–12 years old) and grade 9 (14–15 years old), while non-verbal IQ and other factors played a minor role.

1. Introduction

The first tests measuring cognitive abilities were initially developed in order to predict children's future educational outcomes (Binet & Simon, 1904). Likewise, Charles Spearman extracted for the first time a measurement of general intelligence (the 'g' factor) after observing the positive correlations that exist among school examination scores (Spearman, 1904). Measurements of general intelligence are indeed good predictors of academic achievement, such that their correlation lies between 0.5 and 0.8 (Deary, Strand, Smith, & Fernandes, 2007; Rohde & Thompson, 2007; Roth et al., 2015). However, a substantial part of the variance in academic achievement remains unexplained by general intelligence. Thus, some children under- or over-perform at school relative to what is expected from their level of cognitive ability. This discrepancy between an individual's actual and expected level of academic performance given IQ is known as the IQ-achievement gap (Flynn, 1991; Gordon, 1976). Understanding the different determinants of this gap is of great importance not only for researchers but also for education professionals and policy-makers. Nevertheless, most studies have focused on only one or two specific predictors of achievement beyond intelligence, without considering other important factors.

A first strand of research has looked at the effect of the socio-economic environment on achievement. Family socio-economic status (SES) is a multi-faceted concept (mainly involving income, occupation, and education) that may affect academic performance for different reasons. First, higher financial resources may allow parents to afford private lessons, as well as cultural and educational objects, trips and leisure, which can help children succeed in school. Higher educated parents are also more capable to help their child with homework and provide them with appropriate interactions. Second, SES provides social capital that may help succeed in school (knowledge of the culture and norms valued in school, better relationships with teachers) (Sirin, 2005) as well as higher ambition (Guyon & Huillery, 2016). Numerous studies have demonstrated the predictive role of socio-economic status (SES) (see the meta-analysis by Sirin, 2005) and parental involvement in school (Cheung & Pomerantz, 2012; Hill & Craft, 2003) on academic achievement, but rare are those which took into account measurements of cognitive ability. Not including IQ as a predictor could be misleading because the association between socio-economic status and academic achievement is known to be partly accounted for by general intelligence and mediated by genetic factors (Krapohl & Plomin, 2016). Most of the studies that did include IQ as a covariate had a small sample size or were cross-sectional (Bacete & Remírez, 2001; Johnson, McGue, & Iacono, 2007; Jurecska et al., 2012). More recently, a longitudinal analysis of a large sample of UK students showed that SES had an effect on achievement and its progression from age 7 to 16 independently from IQ (von Stumm, 2017).

Other studies have investigated the influence of self-efficacy,

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namely individuals' beliefs in their own ability to achieve intended results. The idea that self-efficacy affects performance stems from early works by Bandura and colleagues, which argued that it has a positive motivational influence on achievement: students with higher self-efficacy set more difficult goals, work harder, and are more persistent when they face difficulties (for a review, see Zimmerman, 2000). Again, several studies have looked at the effect of self-efficacy on future academic performance (Talsma, Schüz, Schwarzer, & Norris, 2018), but few of them included intelligence as a predictor. Given the (partly genetic) overlap between self-efficacy and cognitive abilities (Greven, Harlaar, Kovas, Chamorro-Premuzic, & Plomin, 2009), it is important to control for IQ when estimating the link between self-efficacy and achievement. Among the few studies that addressed this issue, Chamorro-Premuzic, Harlaar, Greven, and Plomin (2010) found that self-efficacy measured at age 9 increased achievement at age 12 independently from past levels of achievement and cognitive abilities. Similarly, Kriegbaum, Jansen, and Spinath (2015) have shown that self-efficacy was the strongest motivational predictor of performance at PISA mathematics tests at age 16 beyond prior achievement and intelligence (measured at age 15).

Lastly, many researchers have examined the effect of sex, showing the existence of sex differences in academic achievement that cannot be explained by intelligence. For example, Deary et al. (2007) have shown that girls scored higher than boys in almost all subjects of a national exam in the UK (effect size for the overall score was Cohen's $d = 0.3$), even when cognitive ability was taken into account. General intelligence accounted for 49.2% of the variance in GCSE total score, while sex contributed to 3.2% of its variance. Likewise, although in smaller samples, Duckworth and Seligman (2006) and Steinmayr and Spinath (2008) have found an effect of sex on academic performance independent from IQ, such that girls performed higher. Such a positive effect may be the result of girls showing higher levels of self-discipline (Duckworth & Seligman, 2006). On the other hand, other studies have pointed towards an underperformance of girls: for example, results from the PISA studies have shown that girls tend to perform lower than boys in some subjects, in particular in mathematics (OECD, 2015). This might be the consequence of lower levels of self-efficacy in mathematics: controlling for their performance level, girls tend to feel more anxious towards mathematics and have less confidence in their skills than boys (*idem.*). Lower self-esteem and achievement, in particular in mathematics, might result from the internalization of negative stereotypes among girls (Spencer, Steele, & Quinn, 1999).

While these studies inform us about the predictive role of the socio-economic context, self-efficacy and sex on achievement and its progression beyond IQ, they do not provide information on the relative importance of the specific predictors studied compared with each other. Studies that did include a larger range of predictors also had a number of limitations. In a recent article, (O'Connell, 2018) examined the relative contributions of cognitive ability, personality, sex, family background and school characteristics to academic achievement. However, in that study, cognitive ability and personality tests were taken at age 13, while academic achievement was assessed at age 9, which considerably hinders the interpretation of the results.

In order to overcome the above limitations, the present study draws on a rich longitudinal database of French middle school students, which allowed us to estimate the relative contributions of intelligence, self-efficacy, sex and various indices of the socio-economic environment to academic achievement, both cross-sectionally and longitudinally. Data on academic achievement, non-verbal intelligence, individual and contextual factors were all collected twice: in grade 6 (11–12 years old) and grade 9 (14–15 years old). Our study design thus enabled us to estimate the effect of all predictors on academic achievement cross-sectionally, and on the progression in academic achievement between grade 6 and grade 9.

Students' fluid intelligence was assessed with a non-verbal reasoning test (Chartier's Reasoning Test on Playing Cards). We refer to this score as 'non-verbal IQ' throughout the paper. The term 'IQ-achievement gap', left unchanged for the sake of simplicity, thus refers in this paper to the gap between actual achievement and achievement predicted by non-verbal IQ.

We focused on middle-school because international comparisons consistently rank France very low at this particular level: the PISA studies have repeatedly pointed out the stark inequalities at school that face middle-school students from disadvantaged social classes in France (OECD, 2016). Besides, it is worth noting that most studies on academic achievement have been conducted in the US or UK, and very few in France. In one of the rare French longitudinal studies, (Ben Ali & Vourc'h, 2015) have shown a strong impact of social and familial environment on academic progression, but without taking cognitive abilities into account. To the best of our knowledge, no study has examined the predictors of the IQ-achievement gap in France – an analysis that would provide French policy-makers and actors in the education sphere with relevant information.

Based on the results of previous studies, we hypothesized that 1) the gap between achievement and non-verbal IQ is affected by 1a) the social, economic and cultural environment (i.e. the school environment, parental involvement in school, parental education, household income, cultural resources available and extracurricular activities), 1b) self-efficacy, 1c) sex. We further hypothesized that 2) the same factors would further amplify the gap during middle school (from grade 6 to 9).

2. Method

2.1. Sample

As part of a large study led by the *Direction de l'Evaluation, de la Prospective et de la Performance* (DEPP), French Ministry of Education, 34,986 children were followed from their entrance in first year of French middle school (grade 6 – mean age = 11.09, SD = 0.42) in 2007 to their last year of middle school (grade 9 – mean age = 14.21, SD = 0.52) (Trosseille, Champault, & Lieury, 2013).[1] The study was compulsory and approved by the National Council for Statistical Information (CNIS) (visa n°2008A061ED and 2011A082ED), ensuring public interest and conformity with ethical, statistical and confidentiality standards. The sampling strategy consisted in randomly selecting a balanced sample from the characteristics observed in an exhaustive baseline survey. The sample was constituted in such a way as to be representative of the French population of middle school students with a slight over-representation of students in schools belonging to the *Réseau Ambition Réussite* (Success Ambition Network – schools in disadvantaged areas). We excluded from our working sample participants for whom the intelligence, academic achievement scores were missing or equal to zero, or for whom no index of socio-economic status was available. 23,258 participants were thus included in the present study (see Fig. A1).

2.2. Measurements

In grade 6 and grade 9, students completed standardized tests measuring their level of academic performance, non-verbal intelligence and perceived self-efficacy. All tests were administered collectively, in paper/pencil format. In addition, parents were asked to fill a questionnaire giving information on the socio-economic environment and their own degree of involvement in their child's schooling.

2.2.1. Academic achievement

A battery of five tests measuring school-related skills was administered to students.

[1] Panel d'élèves du second degré, recrutement 2007 - 2007-2013, DEPP - Ministère de l'Éducation
[producteur], ADISP-CMH [diffuseur].

- *Phonics skills:* 'Odd-one-out' exercise where participants had to tick the word that does not have a common sound with the others (10 lists of 5 words each).

Example*: fer, aimer, verre, amer, hiver* (\fɛʁ\, \e.me\, \vɛʁ\, \a.mɛʁ\, \i.vɛʁ\)

- *Grammar*: Cloze test (blank-filling task) composed of three short texts with missing logical connectors, determiners, or pronouns (20 items) (J. Aubret, Blanchard, & Sontag, 2006).

Example: « *Septembre*! *C'est le mois…..choisit l'hirondelle pour partir vers le sud du Sahara…..elle peut passer l'hiver au chaud* ». ("September! This is the month… the swallow chooses to fly towards the South of Sahara….it can spend its winter warm").

- *Mathematics:* Exercises of logic, mental arithmetic, problem solving, units and time calculations, and geometry (45 items). Questions were open-ended or multiple choice (F. Aubret & Blanchard, 1992; Blanchard & Berger, 1994; OECD, 2011).

Examples:

- 27 × 20 = …
- *Zoé est plus petite que Joëlle, et elle est plus grande que Cécile. La fille la plus grande s'appelle: 1) Cécile 2) Zoé 3) Joëlle* (Zoé is shorter than Joëlle, and she is taller than Cécile. The tallest girl is named: 1) Cécile 2) Zoé 3) Joëlle)
- *Reading comprehension:* Silent reading of three short texts, each of them followed by five questions. The task was completed in a limited time (12 min) (J. Aubret et al., 2006).

Example: *D'après le texte, combien de garçons escaladent le mur*? … (According to the text, how many boys are climbing on the wall?….)

Quel est celui qui suit le sentier? *C'est…* (Who is following the path? It is…)

- *Academic knowledge:* Multiple choice questionnaire where participants had to tick the best word associated with school manual words in the following disciplines: French, Mathematics, History, Geography, and Sciences (8 items each) (Lieury, 1996, 2012).

Example: *Batracien* (Amphibian)

1) *Grenouille* (Frog)
2) *Chimpanzé* (Chimpanzee)
3) *Oiseau de proie* (Bird of prey)
4) *Je ne sais pas* (I do not know)

The tests administered in grades 6 and 9 were very similar, except for some items that were changed in grade 9 to match students' higher level. Internal consistency was good or acceptable for all measurements (see Table A1). The relatively high correlations between tests in grade 6 and grade 9 suggest a good test-retest reliability for the different tests (see Table 1). 105 participants scored zero at all tests in grade 6, suggesting that they were not engaged in the task; hence they were excluded from the present study (as indicated in Fig. A1). We ran an exploratory factor analysis with the five achievement tests in grades 6 and 9, which yielded a clear one factor solution in both grades (only one factor had an eigenvalue higher than 1, which explained 55% of the variance in grade 6, and 59% in grade 9). We used factor scores resulting from these analyses as our score of academic achievement in each grade (see Table A2).

2.2.2. Non-verbal IQ

Students' non-verbal IQ was assessed in grades 6 and 9 using the *Raisonnement sur Cartes de Chartier* test (RCC, Chartier's Reasoning Test on Playing Cards), that was designed to capture fluid intelligence (*gf*) (Chartier, 2012; Terriot, 2014). The test is made of 30 items assessing children's non-verbal logical reasoning skills, inspired from Raven's progressive matrices (Raven, 1998) but using playing cards. Each item is solved by determining which card (from a deck of 40 playing cards – ten of each suit) would fill the blank in an array composed of 4 to 12 cards. The RCC is scored as the number of items correctly completed in a limited time (20 min). Internal consistency was good ($\alpha = 0.88$ in grade 6 and 0.87 in grade 9; Table A1), and the correlation between RCC scores in grade 6 and RCC scores in grade 9 was relatively strong ($r = 0.61$), indicating a good reliability (Table 1). This correlation is also close to that found by Ramsden et al. (2011) in adolescents of similar age between the non-verbal scores from the Wechsler Intelligence Scale for Children (WISC-III) at time 1 (2004) and the Wechsler Adult Intelligence Scale (WAIS-III) at time 2 (2007/2008) ($r = 0.59$). The distribution of RCC scores was slightly negatively skewed, with a peak at zero (more marked in grade 6). We removed participants who scored zero from our analysis (as indicated in Fig. A1), assuming they were not engaged in the task.

2.2.3. Self-efficacy

In grades 6 and 9, students answered questions from the Children's Perceived Self-Efficacy scales (Bandura, 1990), translated into French. It is a 37-item questionnaire from which factors representing perceived *academic self-efficacy*, *social self-efficacy* and *self-regulatory efficacy* were extracted. The perceived *academic self-efficacy* score was constructed from 19 items that measure students' perceived ability to manage their learning, to master different academic subjects (mathematics, sciences, etc.…), and to fulfill parents' and teachers' expectations. The perceived *social self-efficacy* score includes 13 items measuring efficacy regarding leisure group activities, the ability to form and maintain social relationships and manage interpersonal conflicts, and self-assertiveness. Lastly, the perceived *self-regulatory efficacy* score consists of 5 items measuring students' perceived ability to resist peer pressure to engage in high-risk activities (alcohol, drugs, transgressive behaviors). For each item, students had to evaluate their ability to perform each activity using a 5-points Likert scale. Internal consistency was good for the three indicators (Cronbach's α above 0.80). We ran an exploratory factor analysis with the three self-efficacy indicators in grades 6 and 9, which yielded a clear one factor solution in both grades (only one factor had an eigenvalue higher than 1, which explained 40% of the variance in grade 6, and 35% in grade 9). We used factor scores resulting from these analyses as our score of self-efficacy in each grade (see Table A3).

2.2.4. Socio-economic and cultural environment

Parents or legal guardians filled a questionnaire in grade 6 and grade 9 evaluating the socio-economic and cultural environment in which the child evolves. We created eleven indicators.

2.2.4.1. Parental education. Parents reported their highest diploma, which we converted into years of education completed by each of them (from 0 to 18.5 years −18.5 years corresponding to a graduate degree; $M = 12$, $SD = 3.4$). We then took the mean of both parents as an indicator of parental level of education. When one parents' education was missing, only the other parents' education was taken into account. Mothers' mean education was slightly higher than fathers' (mean difference = 0.1405, $p < .0001$).

2.2.4.2. Household monthly income. Parents filled in household monthly income in grade 6 and grade 9. The relationship between achievement and income was non-linear: the higher the income, the lower the increase in achievement, i.e. the slope of the curve representing achievement as a function of income was positive but less and less steep as income increased (diminishing returns). Therefore we took the natural logarithm of income in order to correctly model this

Table 1
Correlation coefficients between tests in grade 6 and grade 9.

	Tests in grade 6						Tests in grade 9					
	1	2	3	4	5	6	7	8	9	10	11	12
Tests in grade 6												
1. Non-verbal IQ	1											
2. Phonics skills	0.37	1										
3. Grammar	0.46	0.50	1									
4. Mathematics	0.60	0.48	0.64	1								
5. Reading comprehension	0.43	0.43	0.61	0.57	1							
6. Academic knowledge	0.39	0.40	0.61	0.59	0.54	1						
Tests in grade 9												
7. Non-verbal IQ	**0.61**	0.33	0.44	0.59	0.39	0.38	1					
8. Phonics skills	0.36	**0.51**	0.48	0.46	0.40	0.40	0.39	1				
9. Grammar	0.46	0.46	**0.73**	0.63	0.57	0.59	0.51	0.53	1			
10. Mathematics	0.57	0.42	0.58	**0.83**	0.48	0.57	0.65	0.48	0.65	1		
11. Reading comprehension	0.43	0.39	0.62	0.57	**0.56**	0.56	0.48	0.43	0.67	0.59	1	
12. Academic knowledge	0.41	0.39	0.62	0.62	0.53	**0.75**	0.46	0.45	0.67	0.67	0.64	1

Note: Pearson correlation coefficients are reported. All coefficients are significant ($p < .0001$). Correlations between the same tests administered in grade 6 and grade 9 are marked in bold.

relationship.

2.2.4.3. Cultural objects in the house. Parents were asked in grade 6 whether there were books in the household, and if so how many. Their answer to the second question was coded in 4 categories: “between 1 and 29”, “between 30 and 99”, “between 100 and 199”, “200 or more”. The same was asked for CDs. We created a 5-category variable, adding a category “no books” to the four categories described above, which we then standardized; and did the same for CDs. The variable ‘cultural objects in the house’ is the mean of these two standardized variables (whose correlation was equal to 0.59).

2.2.4.4. Extracurricular activities. Parents reported in grade 6 and 9 whether their child was enrolled in: a sports club; a library; a music school; a theatre class; a scout movement (coded as 1 = “Yes”, and 0 = “No”). We took the mean of those answers as an indicator of extracurricular activities.

2.2.4.5. Parental involvement. We ran a principal component analysis of 13 variables linked to parental involvement in grade 6 and grade 9 (with promax rotation since we assumed the factors would be correlated), which yielded five factors based on the scree plot (see Table A4). From these five factors, we created five scores measuring different aspects of parental involvement:

Frequency of conversations between parents and child about school. Parents reported how frequently they had conversations with their child about: homework, school learning, classmates, school life, and teachers. For each question there could be three different answers: “Never or almost never”, “From time to time”, and “Regularly”. We created a score of conversations about school by taking the mean of those 5 questions.

Frequency of conversations between parents and child about the future. Parents reported how frequently they had conversations with their child about their academic future and professional future. We created a score of conversations about the future by taking the mean of those 2 answers.

Involvement in school life. We created a variable measuring parents' degree of involvement in the school by taking the mean of two dichotomous variables indicating whether parents belonged to a parents' association, and whether they were class representatives.

Meeting with teachers. Parents were asked whether they had individual meetings with teachers on their own initiative, and on teachers' initiative. Such meetings may originate from difficulties encountered at school by their child (such as a disrupting behavior or relational problems with classmates for examples). Following the results of the PCA, we created a variable for meetings with teachers taking the mean of those two dichotomous variables.

Commitment to help the child. This last variable is the mean of three dichotomous variables: one indicating whether parents went to a parents-teachers meeting, another indicating whether the child received private tutoring, and a last one indicating whether the child received help with homework. Parents-teachers meetings are meetings where all parents of the same class are invited at the same time to meet the class' teachers, be informed on the class' situation and their child's schooling if they wish. The motivation to go to such meetings is thus very different from going to an individual meeting with a teacher.

2.2.4.6. School environment. In France, two structures for priority education schools existed at the time of the cohort: the RAR (*Réseau Ambition Réussite,* Ambition and Success Network) and the RRS (*Réseau Réussite Scolaire*, Academic Success Network). The RAR included the schools facing the greatest difficulties due to the local socio-economic environment (the 249 most disadvantaged schools, based on social and academic criteria), and the RRS (940 schools) those facing difficulties but not meeting all the criteria to be included in the RAR, and receiving extra-resources in order to counter school failure (Garrouste & Prost, 2015). We created a dummy variable indicating whether students attended a priority education school (RAR or RRS).

2.2.4.7. Parents' origins. We created a dichotomous variable equal to 1 if both parents were born abroad, and to 0 if at least one of the parents was born in France. We chose to group participants who had only one parent born in France with those whose parents were both born in France because they did not differ much in terms of achievement and non-verbal IQ, while those with both parents born abroad had significantly lower achievement and non-verbal IQ (for example, the mean Chartier's Reasoning Test on Playing Cards score for students with two parents born abroad was 12.9, versus 15.1 and 15.9 for students with respectively one and two parents born in France). Such lower results are likely to be the consequence of disadvantages linked to having both parents born abroad, such as speaking a language other than French at home, or a lack of knowledge regarding the French schooling culture.

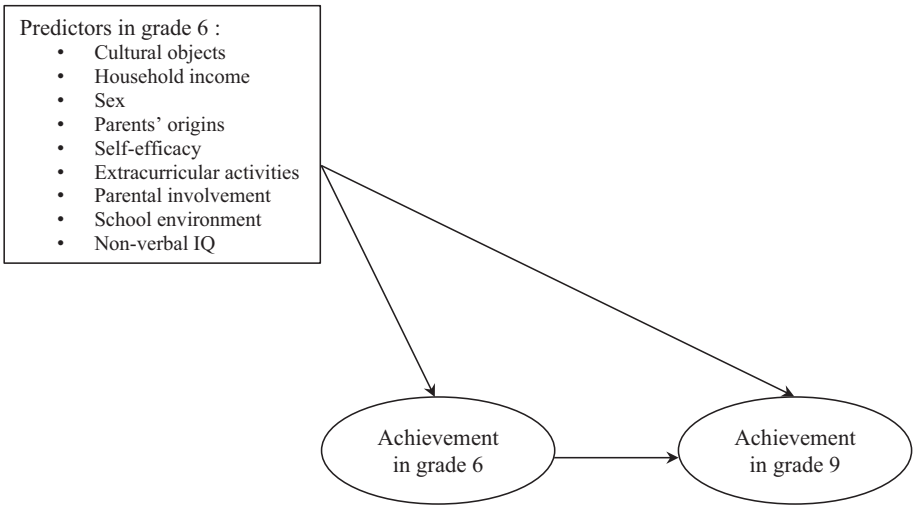

Fig. 1. *Longitudinal structural equation model: effects of predictors on academic progression between grades 6 and 9.*
Note: We allowed errors of the same measured variables across time to be correlated (for example, score in Mathematics in grade 6 and in grade 9). Source: MENESR DEPP.

2.3. Statistical analysis: structural equation models

We analyzed the data using structural equation models (SEM) (Bollen, 1989). Structural equation modeling is a statistical analysis technique that combines multiple regression with factor analysis. It allows us to construct latent variables from several observed variables – thus reducing measurement errors – and to model relationships between these latent variables and predictor variables. We used SEM with maximum likelihood estimation to assess the effect of our various predictor variables (measured, or latent in the case of self-efficacy) on our latent achievement outcome variables in grade 6 and 9. We used multiple imputation to handle the missing data in our predictor variables (for each analysis, ten imputed datasets were created, the analysis was performed on each of the imputed dataset, and parameters from each imputed dataset were averaged out to give the final parameters). We used standardized estimates since they are less affected by the scale of measurement and allow us to compare the relative influence of different predictors. We performed the analyses using SAS 9.4 for data cleaning, recoding and creation of variables as well as for descriptive statistics, and Mplus 8 to run SEMs. Statistical significance of parameter estimates was assessed using a two-sided test, correcting for multiple testing with a Bonferroni correction (for a better readability, we reported only significance for $\alpha = 0.001$, which is roughly 0.05 divided by the number of tests – 28 in the cross-sectional models, 29 in the cross-sectional models, 29 in the longitudinal model). We evaluated goodness of fit using the comparative fit index (CFI), and the root mean squared error of approximation (RMSEA). Modification indices (Chi-square tests) where checked to test if there were significant correlations with any residual.

2.4. Cross-sectional models

We first assessed the relative predictive power of non-verbal IQ, self-efficacy, socio-economic index and sex on academic achievement in grades 6 and 9. We ran a first set of models without non-verbal IQ as a covariate (Models M6 and M9), and a second set including it in order to know how much of the effect of each predictor is explained by non-verbal IQ (Models M'6 and M'9). We hence estimated the following models at t equal to grade 6 and grade 9:

Model M: $Ach_{it} = \beta_1 SE_{it} + \beta_2 Context_{it} + \beta_3 Sex_i + \varepsilon_t$

Model M′: $Ach_{it} = \alpha IQ_{it} + \beta_1 SE_{it} + \beta_2 Context_{it} + \beta_3 Sex_i + \varepsilon_t$

where Ach_{it} is a latent variable for general academic performance of student i at time t such that $Testscore_{it} = \Lambda Ach_{it} + \xi_t$, with *Testscore* a vector of the test scores at the five different achievement tests of student i at time t; IQ_{it} is the non-verbal IQ score from the RCC test of student i at time t; SE_{it} is a latent variable for self-efficacy of student i at time t such that $SE\_score_{it} = \Lambda SE_{it} + \xi_t$, with *SE_score* a vector of the three self-efficacy scores of student i at time t; $Context_{it}$ is a vector of the socio-economic index of student i at time t; and Sex_i is a sex dummy variable taking value 1 if student i is a female.

2.5. Longitudinal model

Next, we estimated to what extent the different factors affect students' academic progression during middle school. We performed a longitudinal SEM estimating the effects of predictors in grade 6 on achievement in grade 9, controlling for achievement in grade 6. We thus estimated the following set of equations with t = grade 9 and t-1 = grade 6:

$$\begin{cases} Ach_{it} = \theta Ach_{it-1} + \alpha IQ_{it-1} + \beta_1 SE_{it-1} + \beta_2 Context_{it-1} + \beta_3 Sex_i + \varepsilon_t \\ Ach_{it-1} = aIQ_{it-1} + b_1 SE_{it-1} + b_2 Context_{it-1} + b_3 Sex_i + \varepsilon_t \end{cases}$$

Fig. 1 illustrates the model.

3. Results

Analyses were conducted on a sample of $N = 23{,}258$ with non-verbal IQ and school achievement scores available and different from zero, and with socio-economic index available, in grades 6 and 9 (Fig. A1). Table 2 presents descriptive statistics of the participants. There were few missing data on socio-economic environment indices (< 2.5% for all indices, with the exception of extracurricular activities – 9.5% – and household income – 43.6% in grade 6) and on self-efficacy scores (< 13% in grade 6).

3.1. Predictors of the IQ-achievement gap in grades 6 and 9

Introducing non-verbal IQ in Models M'6 and M'9 increased the variance of achievement explained from 42% (Table 3, Model M6) to 59% (Table 3, Model M'6) in grade 6, and from 44% (Table 3, Model M9) to 63% in grade 9 (Table 3, Model M'9). Non-verbal IQ had the largest coefficient value of all predictors: an increase of one standard deviation in non-verbal IQ increased achievement by about half a

standard deviation in grades 6 and 9 ($p < .001$). Besides, including non-verbal IQ reduced the coefficients of almost all predictors in absolute value. The only predictor for which we found the opposite effect was sex (from −0.116 without non-verbal IQ to −0.173 with non-verbal IQ in grade 6, and from −0.084 to −0.109 in grade 9; all $p < .001$). We defined the IQ-achievement gap as the difference between actual achievement and that predicted by IQ. It is positive when achievement exceeds what is predicted from IQ. According to our statistical modeling (Models M'6 and M'9), a positive coefficient attached to a given predictor indicates that this predictor contributes to having a higher achievement than predicted by IQ (controlling for other predictors). Therefore, a predictor is associated with a positive IQ-achievement gap when its coefficient in Models M'6 and M'9 is positive. Perceived self-efficacy, parental education, cultural objects in the house, household income, extracurricular activities and conversations between parents and child about school induced a significantly positive IQ-achievement gap (ordered by decreasing effect size). Thus, an increase of one standard deviation in self-efficacy and parental education both increased achievement by about 0.2 of a standard deviation in grade 6 and grade 9. Conversely, being in a priority education school, female sex, meeting with teachers, commitment to help the child, and parents-child conversations about the future induced a significantly negative IQ-achievement gap (ordered by decreasing effect size). Thus, being in a priority education school decreased achievement by about 0.2 of a standard deviation in grade 6 and grade 9. Parents' origins and parental involvement in school life had no significant influence on the IQ-achievement gap. Estimates of the full model (including factor loadings for achievement and self-efficacy indicators) are displayed in Table B1. Fig. 2 illustrates to what extent individual and contextual predictors in the model explain the IQ-achievement gap in grade 6.

4. Predictors of academic progression during middle school

Our longitudinal model explained 87% of the variance in achievement in grade 9. The large coefficient for Achievement in grade 6 (0.85, $p < .001$) shows that our latent construct Achievement is very stable over time (Table 4). As a result, the effects of other predictors are very small (lower than 0.10). Non-verbal IQ in grade 6 significantly predicted progression in achievement throughout middle school, but its effect was small ($\beta = 0.021$; $p < .001$). Change in achievement over middle school was mostly affected by school environment: attending a priority education school in grade 6 reduced achievement in grade 9 by

Table 2
Summary statistics of included participants in grades 6 and 9.

Variable	Grade 6			Grade 9		
	N	*% or M*	*SD*	*N*	*% or M*	*SD*
Child characteristics (%)						
Two parents born abroad	22,544	9.00		22,544	9.00	
Sex (female)	23,258	51.00		23,258	51.00	
Socio-economic status						
Parents' education (years)	23,201	12.08	3.39	23,201	12.08	3.39
Monthly income (EUR)	13,110	2980.62	1982.02	13,562	3331.32	3937.18
Priority education school (%)	23,258	17.00		23,258	16.00	
Perceived self-efficacy (factor score)						
Perceived self-regulation	22,215	0.07	0.96	23,002	0.18	0.68
Perceived academic self-efficacy	20,328	0.07	0.96	22,338	−0.54	1.03
Perceived social self-efficacy	21,168	0.02	0.97	22,495	0.01	0.94
Academic skills (correct items)						
Phonics skills (out of 10)	23,258	6.88	2.13	23,165	7.71	1.75
Grammar (out of 20)	23,258	8.98	4.28	23,181	10.90	4.08
Mathematics (out of 45)	23,258	26.95	8.70	23,211	27.75	10.00
Reading comprehension (out of 15)	23,258	9.75	3.01	23,190	10.33	4.10
Academic knowledge (out of 48)	23,258	28.25	7.30	23,245	31.00	8.11
Non-verbal reasoning test (out of 30)	23,258	15.96	5.86	23,258	18.58	5.81
Parental involvement (%)						
Parents attended a parent-teacher meeting	23,190	92.00		21,417	92.00	
Parents met teacher on their own initiative	23,139	29.00		17,729	41.00	
Parents met teacher on the teacher's initiative	23,141	20.00		17,156	34.00	
Parents part of a parents' association	23,160	14.00		21,962	12.00	
Parents are class representatives	23,165	10.00		19,252	10.00	
Help provided to student at home	23,143	91.00		19,825	73.00	
Private tutoring	22,709	9.00		21,611	13.00	
Frequency of parent-child conversations (from 1 to 3)						
Conversations about homework	23,076	2.88	0.35	22,008	2.74	0.50
Conversations about learning	22,898	2.80	0.44	21,853	2.56	0.59
Conversations about classmates	22,770	2.58	0.57	21,780	2.44	0.64
Conversations about lessons	22,766	2.58	0.56	21,813	2.45	0.61
Conversations about academic future	22,772	2.40	0.64	21,936	2.73	0.48
Conversations about professional future	22,683	2.23	0.70	21,973	2.65	0.54
Cultural objects in the house (from 0 to 5)						
Number of books in the household	22,972	2.39	1.07	22,972	2.39	1.07
Number of CDs in the household	22,684	2.25	0.93	22,684	2.25	0.93
Extracurricular activities (%)						
Sport club	22,167	58.00		21,257	53.00	
Library	21,812	50.00		20,652	36.00	
Music conservatory	21,279	19.00		20,437	17.00	
Theatre class	21,076	6.00		20,206	5.00	
Scouts	21,046	4.00		20,185	4.00	

Note: Frequencies of parents-child conversations are measured on a scale from 1 to 3 (1 = “Never or almost never”, 2 = “From time to time”, 3 = “Regularly”); and numbers of books and CDs on a scale from 0 to 5 (0 = “None”, 1 = “between 1 and 29”, 2 = “between 30 and 99”, 3 = “between 100 and 199”, 4 = “200 or more”).

Table 3
Estimates for models of achievement predictors in grades 6 and 9.
Source: MENESR DEPP.

	Achievement in grade 6		Achievement in grade 9	
	Model M6	Model M'6	Model M9	Model M'9
	$R^2 = 0.42$	$R^2 = 0.59$	$R^2 = 0.44$	$R^2 = 0.63$
Regression coefficients				
Non-verbal IQ		0.473* (0.005)		0.493* (0.005)
Self-efficacy	0.329* (0.008)	0.254* (0.007)	0.288* (0.008)	0.216* (0.006)
Female	−0.116* (0.012)	−0.173* (0.011)	−0.084* (0.012)	−0.109* (0.01)
Household income	0.076* (0.009)	0.061* (0.01)	0.1* (0.01)	0.076* (0.008)
Parental education	0.256* (0.008)	0.204* (0.007)	0.268* (0.008)	0.212* (0.007)
Cultural objects in the house	0.179* (0.007)	0.128* (0.006)	0.18* (0.007)	0.128* (0.006)
Priority education school	−0.289* (0.016)	−0.197* (0.015)	−0.305* (0.016)	−0.221* (0.014)
Extracurricular activities	0.047* (0.006)	0.04* (0.005)	0.077* (0.006)	0.06* (0.005)
Parents born abroad	−0.076 (0.022)	−0.026 (0.019)	−0.137* (0.022)	−0.06 (0.018)
Conversations about school	0.031* (0.007)	0.033* (0.006)	0.025* (0.007)	0.025* (0.005)
Conversations about future	−0.076* (0.006)	−0.051* (0.006)	−0.084* (0.007)	−0.057* (0.005)
Involvement in school life	0.026* (0.006)	0.012 (0.005)	0.035* (0.006)	0.021* (0.005)
Meeting with teachers	−0.145* (0.006)	−0.095* (0.005)	−0.159* (0.007)	−0.093* (0.005)
Child help	−0.125* (0.006)	−0.089* (0.005)	−0.112* (0.006)	−0.064* (0.005)

Note: Standardized estimates are reported. Standard errors are in parenthesis. N = 23,258. Non-verbal IQ, Self-efficacy, Household income, Priority education school, Extracurricular activities, Conversations about school, Conversations about future, Involvement in school life, Child help, and Meeting teachers are measured in grade 6 in Models M6 and M'6, and in grade 9 in Models M9 and M'9. Model M6: RMSEA = 0.068, CFI = 0.847; Model M'6: RMSEA = 0.071 CFI = 0.836; Model M9: RMSEA = 0.066, CFI = 0.865; Model M'9: RMSEA = 0.072, CFI = 0.849.
* $p < .001$

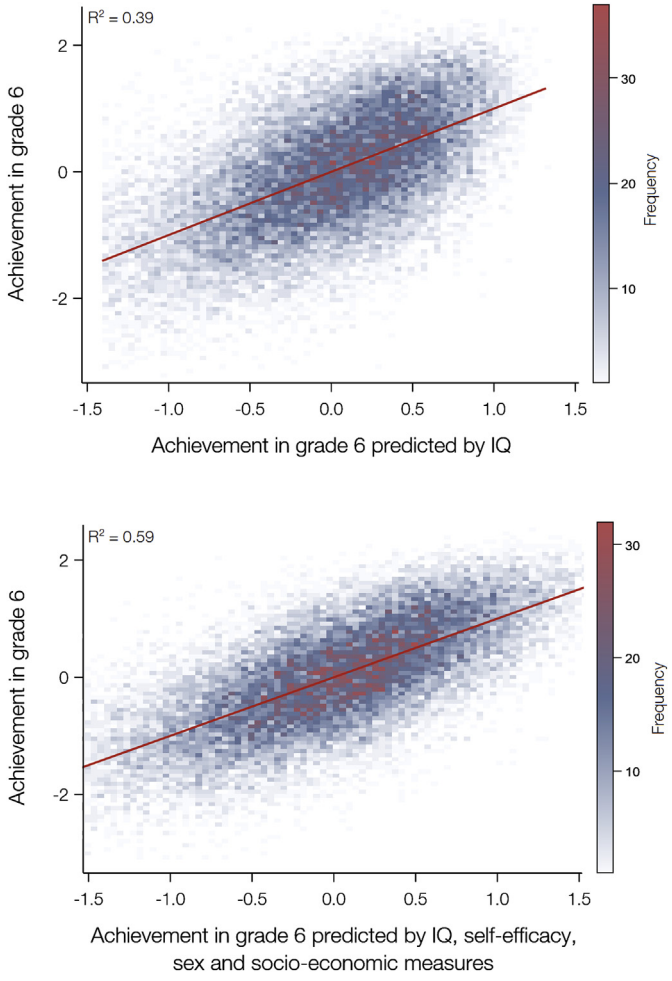

Fig. 2. Relation between actual achievement and predicted achievement in grade 6.

Table 4
Effects of predictors in grade 6 on academic progression between grade 6 and grade 9.

	Estimates of the longitudinal model	
	R^2 for achievement in grade 9 = 0.87	
	β	*SE*
Predictors of achievement in grade 9		
Achievement in grade 6	0.851*	0.005
Non-verbal IQ	0.021*	0.005
Self-efficacy	0.015	0.005
Female	0.01	0.007
Household income	0.029*	0.006
Parental education	0.048*	0.005
Cultural objects in the house	0.022*	0.004
Priority education school	−0.07*	0.01
Extracurricular activities	0	0.004
Parents born abroad	0.008	0.013
Conversations about school	0.016*	0.004
Conversations about future	−0.017*	0.004
Involvement in school life	0.014*	0.004
Meeting with teachers	−0.027*	0.004
Child help	−0.004	0.004

Note: Standardized estimates are reported. $N = 23{,}258$. RMSEA = 0.062, CFI = 0.904.
* $p < .001$.

0.07 standard deviation ($p < .001$). Parental education had a moderate and significantly positive influence on academic progression ($\beta = 0.05$), while household income, cultural objects in the house, and parental involvement in school life had a significantly positive but small impact. Likewise, conversations about future and meetings with teachers had a significant negative influence on progression, but their effects were small. Extracurricular activities, conversations about school, and commitment to help the child had no significant effect, as well as parents' origins, self-efficacy and sex. Estimates of the full model (including regression coefficients from predictors in grade 6 to achievement in grade 6, and factor loadings for achievement and self-efficacy indicators) are displayed in Table B2.

5. Discussion

The aim of this study was to assess the contributions of various environmental and individual factors to the IQ-achievement gap – i.e., the part of achievement that is not predicted by IQ – during middle school. Our study confirmed that cognitive ability is an important predictor of academic achievement, even when taking into account a wide range of contextual and individual factors. Indeed, non-verbal IQ was by far the most predictive factor of achievement in grades 6 and 9, and not including it induced biased estimates for other independent variables. However, it had a small effect on the variations in achievement during middle school compared to other factors. These results thus confirm the undeniable and widely reported role of intelligence (here non-verbal intelligence) in explaining academic performance at a given time, but show that it has a marginal role in explaining progression.

5.1. Environment and the IQ-achievement gap

School environment, parental education and cultural objects in the house were the environmental factors that had the strongest influence on academic achievement, independently of non-verbal IQ (coefficients respectively equal to −0.2, 0.2, and 0.13) (Hypothesis 1a). These factors also significantly (but modestly) affected academic progression over middle school, thus showing their long-lasting and cumulative effects (coefficients were small, equal to −0.07, 0.05 and 0.02, respectively) (Hypothesis 2). Students from highly educated families and those who had access to cultural resources at home not only succeeded more than expected given their non-verbal IQ in grades 6 and 9, but also seem to have progressed more than their peers, thereby increasing the gap. Household income also positively affected the IQ-achievement gap and academic progression, although more moderately, while extracurricular activities were positively associated with the IQ-achievement gap but did not affect progression.

Conversely, students enrolled in middle schools in disadvantaged areas in grade 6 performed lower than expected in grades 6 and 9, and regressed compared to their peers, although RAR and RRS schools received additional State funding and personnel. Our data does not allow us to determine whether these additional resources had the intended effects because the corresponding variables were not available. However, our results suggest that the additional resources allocated to the RAR and RRS schools certainly did not suffice to compensate all the difficulties linked to disadvantaged areas. These results echo those of Bénabou, Kramarz, and Prost (2009), who estimated the impact of the former *Zones d'Education Prioritaire* program (Priority Education Zones; that preceded the RAR and RRS) on academic achievement in the 1980s. They had found that in spite of decreases in class size and increases in teaching hours per student in the concerned schools, the effect was nil. Such findings point towards the need for further research on the impact of more recent priority school programs, in order to improve the allocation of resources and their effect.

Contrary to our expectations, the effect of parental involvement indices was overall negative. On the one hand, conversations between parents and child about school and parental involvement in school life were positively related with the IQ-achievement gap and academic progression – which is in line with past research (Cheung & Pomerantz, 2012; Hill & Craft, 2003) –, but their effects were small or non-significant (< 0.03). On the other hand, conversations with the child about professional future, help provided to the child, and meetings with teachers were negatively associated with the IQ-achievement gap, and negatively influenced academic progression (even though their effect on progression was small or non-significant – coefficients lower than 0.1). Thus, these variables may reflect a combination of the expected positive effect and of the opposite one, i.e., that children with more difficulties (that were not entirely captured by non-verbal IQ nor achievement, such as behavioral problems) generate more conversations about their schooling and their future, need more help with homework, and more meetings between parents and teachers. The net effect being negative suggests that the latter relationship is predominant.

These associations between family and school environments and achievement are likely to be partly mediated by genetic factors. Indeed, heritability studies on a large sample of UK twins have shown that common genetic influences accounted for 59% of the correlation between results at a national examination and perceptions of school environment (Krapohl et al., 2014), and half the correlation between achievement and family SES (Krapohl & Plomin, 2016).

5.2. Perceived self-efficacy and the IQ-achievement gap

Perceived self-efficacy proved to be one of the most predictive factors of academic achievement in grades 6 and 9 after non-verbal IQ (effect around 0.2) (Hypothesis 1b). However, it did not significantly affect academic progression during middle school, contrary to our hypothesis (Hypothesis 2). Hence, students with higher levels of perceived self-efficacy had higher results than expected from their non-verbal IQ, but did not progress more than their peers. This effect of self-efficacy on academic achievement is likely to be partly accounted for by genetic factors, as > 60% of the association between self-efficacy and achievement is mediated genetically (Greven et al., 2009; Krapohl et al., 2014). However, in the case of cross-sectional models, it may also be noted to be partly circular, in the sense that children's achievements, as attested by their grades, probably affected their perceived self-efficacy, since both were measured at the same time.

Besides, our cross-sectional and longitudinal models showed that non-verbal IQ in grades 6 and 9 predicted results in standardized academic tests better than did self-efficacy. This result is consistent with those of a cross-cultural (Dutch, UK and US) study conducted by Borghans, Golsteyn, Heckman, and Humphries (2016), who found that IQ predicted results at standardized achievement tests better than did personality, while personality predicted teacher grades better than did IQ.

5.3. Sex differences

Our results indicated that girls under-performed (β lower than −0.1) compared to what could be expected from their non-verbal IQ in grades 6 and 9 (Hypothesis 1c). Interestingly, while the effect of being a girl was negative in models that did not include non-verbal IQ as a predictor (Table 3, Models M6 and M9), it became even more negative once non-verbal IQ was added (Table 3, Models M'6 and M'9). This is due to the fact that in this population, girls scored slightly higher than boys in non-verbal IQ (d = 0.115 in grade 6 and 0.046 in grade 9). Given this higher non-verbal IQ, higher level of achievement was expected, which was not the case. However, overall progression in academic skills during middle school was not affected by sex; thus, Hypothesis 2 was not confirmed for sex. These results contrast with those of Deary et al. (2007), who had found that English girls performed better than boys, independently from IQ. Such difference may partly come from cultural differences, from the nature of the academic tests considered, or even from the absence of environmental factors and self-efficacy indicators in their study.

5.4. Limitations

Our results may be weakened by the lack of several factors that

could influence the IQ-achievement gap, such as genetic factors, parental IQ, early cognitive abilities and behavioral or emotional difficulties, whose absence may have biased some of the coefficients. Genetic factors are a first important confounder. Indeed, there exists a significant genetic overlap between perceived school environment, home environment, intelligence and achievement (Krapohl et al., 2014). Genes have also been found to mediate up to half the correlation between achievement scores and family SES, with only one third of this association accounted for by general intelligence (Krapohl & Plomin, 2016). Similarly, a significant part of the genetic covariance between self-perceived abilities and achievement is independent of IQ (Greven et al., 2009). Therefore, the effects of parental education, school environment and self-efficacy are likely to be overestimated due to the absence of genetic factors. Likewise, the absence of behavioral problem indicators may have led us to overestimate the coefficient of non-verbal IQ, as hyperactivity and conduct problems (which are negatively associated with IQ) negatively affect achievement independently of IQ (Breslau et al., 2009; Fergusson & Horwood, 1995).

Besides, our data did not include other factors that have an effect on achievement and that may also have an effect on intelligence independently from IQ, such as implicit theories of intelligence: whether a student holds a 'fixed mindset' (believes that intelligence and ability in different subjects is a fixed trait – *entity theory*) or a 'growth mindset' (believes that intelligence is malleable and can be developed – *incremental theory*) may significantly affect their progression in achievement. Indeed, Blackwell, Trzesniewski, and Dweck (2007) showed that having a growth mindset predicts an increase in grades during middle school, while having a fixed mindset predicts a flat trajectory (but they did not control for IQ). This result was confirmed by a classroom intervention teaching the incremental theory to students: while students from the control group experienced a continuing decline in grades, students from the experimental group experienced a positive rebound. Lastly, our parental SES and priority education school variables may have incompletely captured the effects of community, school or class, which also have an impact on achievement (Burke & Sass, 2013; McEwan, 2003; D. J. Zimmerman, 2003), possibly independently of the IQ level.

Lastly, our study was also limited by the fact that only non-verbal IQ was measured. Verbal IQ reflecting more crystallized intelligence and being therefore closer to achievement scores, the part of achievement variance explained by total IQ might have been even greater than explained here by the Chartier's Reasoning Test on Playing Cards.

6. Conclusion

Using a large longitudinal cohort of French middle school students, our study allowed us to cast light on the relative contributions of a broad range of environmental and individual factors explaining why students under- or over-perform relative to what can be expected from their non-verbal IQ. Results showed that perceived self-efficacy, school environment, parental education and sex were the factors that most affected academic achievement independently of non-verbal intelligence cross-sectionally – although intelligence was by far the best predictor. Longitudinally, school context and parental education best predicted progression in achievement between grade 6 and grade 9, while intelligence and other factors played a minor role. Our results thus demonstrate the powerful role of the socio-economic context, which not only has a major influence on academic achievement beyond intelligence, but also affects academic progression during middle school, such that inequalities keep growing.

Declarations of interest

None.

Acknowledgements

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Appendix A. Data

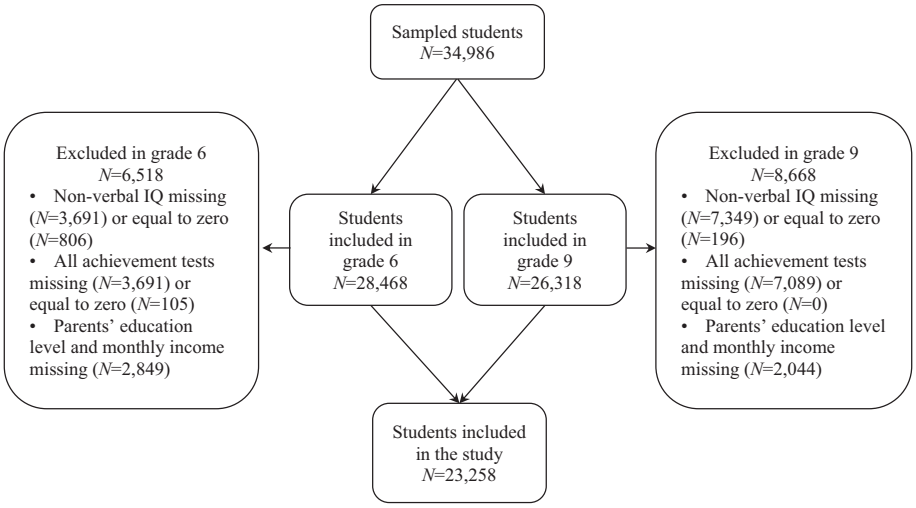

Fig. A1. Flowchart of included and excluded participants.
Source: MENESR DEPP.

Table A1
Internal consistency for scores in grade 6 and grade 9.

Test	Cronbach's alpha	
	Grade 6	Grade 9
Non-verbal IQ	0.876	0.869
Academic knowledge	0.856	0.884
Reading comprehension	0.743	0.816
Mathematics	0.906	0.935
Grammar	0.831	0.817
Phonics skills	0.672	0.641
Academic self-efficacy	0.863	0.864
Social self-efficacy	0.805	0.801
Self-regulation	0.894	0.809

Table A2
Results from exploratory factor analyses (EFA) with achievement scores in grades 6 and 9.

Test	Factor loadings in grade 6	Factor loadings in grade 9
Phonics skills	0.59	0.59
Grammar	0.83	0.85
Mathematics	0.79	0.79
Reading comprehension	0.73	0.78
Academic knowledge	0.74	0.82

Table A3
Results from exploratory factor analyses (EFA) with self-efficacy scores in grades 6 and 9.

Scores	Factor loadings in grade 6	Factor loadings in grade 9
Perceived self-regulation	0.42	0.47
Perceived academic self-efficacy	0.75	0.81
Perceived social self-efficacy	0.69	0.41

Table A4
factor structure from the principal component analysis with promax rotation of parental involvement variables in grade 6.

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Parents attended a parent-teacher meeting	0.098	0.021	0.143	−0.332	**0.633**
Parents met teacher on their own initiative	0.106	0.084	0.075	**0.755**	0.049
Parents met teacher on the initiative of the teacher	−0.064	0.063	−0.095	**0.743**	−0.043
Parents part of a parents' association	0.089	−0.016	**0.897**	−0.025	0.055
Parents are class representatives	0.093	−0.003	**0.897**	−0.028	0.046
Private tutoring	−0.052	0.128	0.001	0.369	**0.424**
Help provided to student at home	0.174	−0.031	−0.026	0.115	**0.662**
Conversations about homework	**0.746**	0.141	0.024	0.035	0.221
Conversations about learning	**0.823**	0.234	0.062	0.023	0.179
Conversations about classmates	**0.750**	0.331	0.137	−0.045	−0.009
Conversations about lessons	**0.738**	0.432	0.121	−0.013	0.032
Conversations about academic future	0.364	**0.919**	−0.005	0.113	0.028
Conversations about professional future	0.291	**0.927**	−0.013	0.078	0.006

Note: The highest loadings for each factor are marked in bold and indicate the variables that were grouped together to form five scores of parental involvement.

Appendix B. Results

Table B1
Estimates for models of the achievement predictors in grades 6 and 9.
Source: MENESR DEPP.

	Achievement in grade 6		Achievement in grade 9	
	Model M6	Model M'6	Model M9	Model M'9
	$R^2 = 0.42$	$R^2 = 0.59$	$R^2 = 0.44$	$R^2 = 0.63$
Regression coefficients				
Non-verbal IQ		0.473* (0.005)		0.493* (0.005)
Self-efficacy	0.329* (0.008)	0.254* (0.007)	0.288* (0.008)	0.216* (0.006)
Female	−0.116* (0.012)	−0.173* (0.011)	−0.084* (0.012)	−0.109* (0.01)
Household income	0.076* (0.009)	0.061* (0.01)	0.1* (0.01)	0.076* (0.008)
Parental education	0.256* (0.008)	0.204* (0.007)	0.268* (0.008)	0.212* (0.007)
Cultural objects in the house	0.179* (0.007)	0.128* (0.006)	0.18* (0.007)	0.128* (0.006)
Priority education school	−0.289* (0.016)	−0.197* (0.015)	−0.305* (0.016)	−0.221* (0.014)
Extracurricular activities	0.047* (0.006)	0.04* (0.005)	0.077* (0.006)	0.06* (0.005)
Parents born abroad	−0.076 (0.022)	−0.026 (0.019)	−0.137* (0.022)	−0.06 (0.018)
Conversations about school	0.031* (0.007)	0.033* (0.006)	0.025* (0.007)	0.025* (0.005)
Conversations about future	−0.076* (0.006)	−0.051* (0.006)	−0.084* (0.007)	−0.057* (0.005)
Involvement in school life	0.026* (0.006)	0.012 (0.005)	0.035* (0.006)	0.021* (0.005)
Meeting with teachers	−0.145* (0.006)	−0.095* (0.005)	−0.159* (0.007)	−0.093* (0.005)
Child help	−0.125* (0.006)	−0.089* (0.005)	−0.112* (0.006)	−0.064* (0.005)
Factor loadings for achievement				
Phonics skills	0.573* (0.005)	0.569* (0.005)	0.567* (0.005)	0.566* (0.005)
Grammar	0.815* (0.003)	0.795* (0.003)	0.83* (0.003)	0.816* (0.003)
Mathematics	0.79* (0.003)	0.822* (0.003)	0.791* (0.003)	0.821* (0.003)
Reading comprehension	0.711* (0.004)	0.7* (0.004)	0.762* (0.003)	0.752* (0.003)
Academic knowledge	0.734* (0.004)	0.72* (0.004)	0.818* (0.003)	0.803* (0.003)
Factor loadings for Self-efficacy				
Autoregulation	0.457* (0.008)	0.446* (0.008)	0.48* (0.009)	0.467* (0.009)
Academic self-efficacy	0.793* (0.007)	0.793* (0.008)	0.816* (0.011)	0.833* (0.012)
Social self-efficacy	0.628* (0.007)	0.636* (0.007)	0.393* (0.007)	0.392* (0.007)

Note: Standardized estimates are reported. Standard errors are in parenthesis. N = 23,258. Non-verbal IQ, Self-efficacy, Household income, Priority education school, Extracurricular activities, Conversations about school, Conversations about future, Involvement in school life, Child help, and Meeting teachers are measured in grade 6 in Models M6 and M'6, and in grade 9 in Models M9 and M'9. Model M6: RMSEA = 0.068, CFI = 0.847; Model M'6: RMSEA = 0.071 CFI = 0.836; Model M9: RMSEA = 0.066, CFI = 0.865; Model M'9: RMSEA = 0.072, CFI = 0.849.

* $p < .001$.

Table B2
Effects of predictors in grade 6 on academic progression between grade 6 and grade 9.
Source: MENESR DEPP.

	Estimates of the longitudinal model	
	R^2 for Achievement in grade 9 = 0.87	
	β	*SE*
Predictors of achievement in grade 9		
Achievement in grade 6	0.851*	0.005
Non-verbal IQ	0.021*	0.005
Self-efficacy	0.015	0.005
Female	0.01	0.007
Household income	0.029*	0.006
Parental education	0.048*	0.005
Cultural objects in the house	0.022*	0.004
Priority education school	−0.07*	0.01
Extracurricular activities	0	0.004
Parents born abroad	0.008	0.013
Conversations about school	0.016*	0.004

(*continued on next page*)

Table B2 (*continued*)

	Estimates of the longitudinal model	
	R^2 for Achievement in grade 9 = 0.87	
	β	*SE*
Conversations about future	−0.017*	0.004
Involvement in school life	0.014*	0.004
Meeting with teachers	−0.027*	0.004
Child help	−0.004	0.004
Predictors of achievement in grade 6		
Non-verbal IQ	0.455*	0.005
Self-efficacy	0.256*	0.007
Female	−0.109*	0.011
Household income	0.051*	0.008
Parental education	0.207*	0.007
Cultural objects in the house	0.134*	0.006
Priority education school	−0.196*	0.015
Extracurricular activities	0.041*	0.005
Parents born abroad	−0.036	0.02
Conversations about school	0.037*	0.006
Conversations about future	−0.049*	0.006
Involvement in school life	0.01	0.005
Meeting with teachers	−0.093*	0.005
Child help	−0.088*	0.005
Factor loadings for Achievement in grade 9		
Phonics skills	0.578*	0.005
Grammar	0.833*	0.002
Mathematics	0.792*	0.003
Reading comprehension	0.763*	0.003
Academic knowledge	0.801*	0.003
Factor loadings for achievement in grade 6		
Phonics skills	0.564*	0.005
Grammar	0.81*	0.003
Mathematics	0.811*	0.003
Reading comprehension	0.705*	0.004
Academic knowledge	0.727*	0.003
Factor loadings for Self-efficacy in grade 6		
Autoregulation	0.447*	0.008
Academic self-efficacy	0.796*	0.008
Social self-efficacy	0.63*	0.007
Correlations between the same academic skills in grade 6 and grade 9		
Phonics skills	0.303*	0.006
Grammar	0.28*	0.008
Mathematics	0.64*	0.005
Reading comprehension	0.11*	0.007
Academic knowledge	0.469*	0.006

Note: Standardized estimates are reported. N = 23,258. RMSEA = 0.062, CFI = 0.904.

* $p < .001$.

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