



Understanding the academic achievement of the first- and second-generation immigrant students: a multi-level analysis of PISA 2018 data

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Abstract

The present study explores the antecedents of first- and second-generation (1G and 2G) immigrant students' academic performance using PISA 2018 data. The study draws on an international sample of 11,582 students from 534 schools in 20 countries and focuses on PISA schools that catered to a mix of 1G and 2G students. The study explores the role that student attributes, student-perceived peer and parental support, school provisions, and school equity-oriented policies have on immigrant student academic achievement. The analysis involved specifying three separate stepwise multi-level regression models for mathematics, science, and reading achievement. Findings suggested that, at the within-school level, perceived parental support and teacher enthusiasm and the adaption of instruction were associated with improved academic performance, while student experience of bullying was associated with more substantive negative academic outcomes. At the between-school level, the opportunity to participate in creative extracurricular activities was associated with improved academic performance. In contrast, a higher proportion of 1G students and the overall perceived level of bullying of immigrant students were associated with substantively negative academic outcomes between schools. Tests of moderation effects suggested that parental emotional support appeared to be of particular relevance to 1G students' math and reading outcomes, while enhanced SES status appeared to be specifically relevant to improved science and reading outcomes for 1G students. Implications for policy and practice are discussed.

Keywords Immigrant students · OECD PISA · Mathematics · Science · Reading · Achievement · Multi-level modelling

The integration of immigrant students into the education system is of major concern to most countries worldwide. The Programme for International Student Assessment (PISA) results indicate a significant and persistent achievement gap between

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first-generation (1G) and second-generation (2G) immigrants and their native counterparts in mathematics, science, and reading (MSR) (Volante et al., 2019). Poor outcomes in higher education and fewer work opportunities often follow immigrant students' lower academic performance at school (Volante et al., 2019). Therefore, immigrant students' social and academic integration is a critical issue, especially for education systems, with a massive influx of immigrant students (Kogan, 2016; Zubikova, 2020). In an attempt to understand immigrant student integration, the present study examines the antecedents of immigrant students' academic performance in mathematics, science, and reading by examining the role of student attributes and experiences at school and home, school provisions, school equity-oriented policies, and country gross domestic product (GDP) per capita.

Two groups of immigrant students were included in the analysis: 1G and 2G students, with 1G referring to students whose parents were born in a country different from the country where the assessment took place, *and* were themselves born in a country different from where the assessment took place; and 2G referring to students whose parents were born in a country different from where the assessment took place, *who* were themselves born in the same country in which the assessment took place.

Research has found that, as a consequence of the recent transition to host countries, 1G students face more difficulties in adjusting to the dominant cultures and unfamiliar schooling systems and face more barriers to learning a new language (Martin et al., 2012). Though being more established in their host country and less likely to experience the same level of challenges, 2G students are not entirely exempt. An inhibitor to their integration is 2G parents of students who often exhibit lower levels of education and socioeconomic status, with some also experiencing ongoing language fluency problems (Martin et al., 2012). Previous research identified a higher discrepancy in academic achievement between the 1G and native students compared to the discrepancy between 2G and native students (Meunier, 2011; Retali, 2011; Rumbaut, 2004). Furthermore, it is often argued that the achievement gap between 1 and 2G students provides insight into how effective school systems are in supporting the growth and development of immigrant students (OECD, 2006).

Immigrant students frequently perform more poorly at school than their native student counterparts (Ammermueller, 2007; Borgna, 2016; Colding et al., 2009; Entorf & Lauk, 2008; He & Fischer, 2020). To explain this, Jensen and Rasmussen suggested that the proportion of immigrant students at a school is one of the primary causes of poor educational outcomes in general. Specifically, the immigrant concentration at a school has been found to reduce the achievement of the associated immigrant *and* native student groups (Brunello & Rocco, 2013; Gould et al., 2009; Jensen & Rasmussen, 2011; Schneeweis, 2015). Entorf and Lauk (2008) posited that the primary mechanism for reduced levels of overall achievement of both the immigrant and non-immigrant students was the result of an overall negative peer effect which stems from a *disproportionate* level of low achievement among immigrant student groups exhibited in the school. Brunello and Rocco (2013) have proposed that a higher proportion of immigrant students in a school is associated with a reduction in teacher attention, due to the teaching resources that immigrants absorb,

afforded toward students in general, and this reduction in attention may account for the general lower academic performance.

However, other research findings run counter to this idea suggesting that a higher proportion of immigrants at school yields more positive educational outcomes for native and immigrant students, indicating that ethnic and socio-cultural diversity is associated with positive educational outcomes (Brandén et al., 2019; Fekjær & Birkelund, 2007; Hermansen & Birkelund, 2015; Silveira et al., 2019). The current study contributes to this debate by exploring how the proportion of first-generation students compared to second-generation students reflects the overall level of academic achievement of immigrant students in schools.

Several explanations and theories have been proposed in the literature to explain why immigrant students might exhibit lower cognitive skills and, thus, lower academic performance. Immigrant status can be considered a type of minority status and its influence on cognitive skills is moderated by other factors related to social position variables (e.g., gender, language background, and proficiency), inhibiting/promoting environments (e.g., students' attributes and experience, school provisions and policies), "segregation," and "family" factors (e.g., socioeconomic status (SES)) (García Coll et al., 1996). Commonly, factors related to social stratification, as a function of discrimination, racism, prejudice, or segregation, set immigrants apart from the dominant culture with immigrant groups often developing an adaptive culture as a product of the contextual demands that inhibiting/promoting environments such as schools pose (García Coll et al., 1996). The concept of "stereotype threat" suggests that negative experiences and attributes related to racial stereotypes impair immigrant students' cognitive functioning while trying to protect their self-worth (Steele, 1997). Research indicated that the stereotype threat would reduce the working memory capacities and cognitive abilities of students, thus, lowering their academic performance (Schmader & Johns, 2003). Besides, cultural differences can impact 1G immigrants' experiences with social segregation, which also affects academic performance (García Coll et al., 1996).

Research evidence suggests that immigrant students from low SES backgrounds often perform worse than their immigrant and non-immigrant equivalents with higher SES (Volante, 2016). Families with low education levels and limited financial resources lack the ability to support their children's education and academic activities (Schleicher & Zoido, 2016). Similarly, low SES families often settle in low SES neighborhoods and the schools in such segregated areas are more disadvantaged in providing the required resources and services for the adaptation and education of immigrant students (Schleicher & Zoido, 2016; Strelakova-Hughes, 2017).

Based on García Coll et al.'s (1996) theoretical framework that conceptualizes the possible antecedents of immigrant students' academic performance, the present study analyzed the following variables: gender as a social position; economic, social, and cultural status (ESCS) as a "segregation" or "family" factor; various student attributes and experiences, school provisions, and equity-oriented school policies as factors associated with inhibiting/promoting environments.

From among the student attributes and experiences available in the PISA 2018 dataset, this study selected parents' emotional support perceived by students, perceived teacher's interest (perceived by students), the adaptation of instruction (by

the teacher, as perceived by students), and students' experience of being bullied. For variables on school provisions, the study selected school type (public or private), creative extracurricular activities provided by the school, as well as a shortage of educational material and educational staff. Concerning indicators of a school's specialized immigrant student policy, the study used the PISA scale of school's equity-oriented policies comprising five policy-specific items. The GDP per capita of countries were used as a possible indicator of segregation or achievement gaps. As Hochschild and Cropper (2010), Crul and Mollenkopf (2012), and Crul et al. (2012) indicated, there tend to be fewer discrepancies in the academic performance of immigrant students in the countries providing support for upward mobility. Indeed, developed countries with higher GDP per capita and those that provide more support for upward mobility have fewer gaps in immigrant students' achievement scores (OECD, 2006).

1 Theoretical background

1.1 Gender as a social position variable

The literature suggests that female students are more likely to experience socio-emotional problems such as higher levels of negative affect, anxiety, and depression, and more interpersonal stressors that are critical antecedents of academic performance (Alivernini et al., 2020; Chaplin and Aldao 2013). Given their socio-emotional sensitivities, research suggests that the educational outcomes of female immigrant students, especially 1G females, are more likely to deteriorate than males under the adverse circumstances in which they are mistreated and suppressed because of heavy family responsibilities at home (Fulgini & Pederson, 2002; Vaquera & Kao, 2012). However, regardless of immigrant status, females generally exhibit higher levels of academic motivation than males (Alivernini et al., 2018). In terms of general academic performance, female students more frequently achieve higher scores in reading while males score higher in science and mathematics (Arikan et al., 2017; Guiso et al., 2008; Marks, 2008; Martin, 2004, 2006; Martin et al., 2012).

1.2 ESCS as a segregating factor

Findings from previous PISA cycles invariably reveal that students from a higher socioeconomic background generally achieve higher levels of academic performance (OECD, 2010). Furthermore, research also suggests that the proportion of the high ESCS students at a school positively impacts the overall achievement of the students studying at that school (Aikens & Barbarin, 2008; Langenkamp & Carbonaro, 2018; Zhang & Liu, 2016). In most countries, the parents of immigrant students are less educated than their native parent counterparts, and immigrant families have lower levels of ESCS, which is strongly associated with lower levels of academic performance (Schleicher, 2006). Therefore, ESCS, as a segregation factor, may distinguish some immigrants from others, and this effect may be more substantial for the most

vulnerable immigrant groups (1G students). Notably, the literature also suggests that immigrant students from a higher ESCS background feel a stronger sense of belonging to the school and have better academic performance (He & Fischer, 2020), and a higher ESCS background generally provides an advantage, especially for 1G students (Harju-Luukkainen et al., 2017; Silveira et al., 2019).

1.3 Factors of inhibiting/promoting environments

1.3.1 Student attributes and experiences

Research suggests that supportive relationships with parents at home and teachers at school can make a substantial contribution to both the academic engagement and achievement of immigrant students (Garcia-Reid et al., 2015; Suárez-Orozco et al., 2009). The particular interest and emotional support of teachers provide immigrant students with a sense of safety and can help them to build confidence, self-efficacy, specific skills, and to adjust to a new country (Garcia-Reid et al., 2015; Ly et al., 2012; Suárez-Orozco et al., 2009). Teachers' adaptation of instruction to the individual prerequisites and needs of students, as more tangible support at school, is considered essential for teaching heterogeneous and diverse student groups effectively (Weiss et al., 2019), especially immigrant students (Suárez-Orozco et al., 2009).

Outside-school support received from caring adults, such as academic guides, cultural interpreters, and caring role models can provide a form of practical assistance and emotional support for immigrant youth often crucial for their adjustment to a new educational context (Garcia-Reid et al., 2015; Rumberger, 2004; Suárez-Orozco et al., 2009). Although most immigrant parents have a deep concern about the education of their children and try their best to support them, they face many challenges in terms of their limited language proficiency and limited experience in the new educational context (Garcia-Reid et al., 2015). Nevertheless, the literature has not addressed the degree to which supportive parental and teacher relationships might be related to immigrant student achievement in specific subject areas.

Compared with their native and later-generation counterparts, 1G immigrant students are more likely to experience bullying at school, reflective of an unsafe and unsupportive school environment (Alivernini et al., 2019; Pottie et al., 2015; Stevens et al., 2020). The exposure of immigrants to bullying poses risks for their identity, mental health, and adjustment (Bellmore et al., 2004; Chisolm et al., 2009) and may be associated with poorer academic outcomes (Lee et al., 2017, 2018; Suárez-Orozco et al., 2009). However, the literature has yet to address the extent to which individual bullying, and the broader culture of bullying in a school, might reflect on multiple academic outcomes.

1.3.2 Variables regarding school provisions

School type (public or private), creative extracurricular activities provided by the school, shortage of educational material, and shortage of academic staff are among

the variables related to school provisions in the PISA 2018 data set that may influence the achievement of immigrant students (OECD, 2018).

Schools may differ in terms of the proportion of immigrant students, which, in turn, can influence the socioeconomic status of a school. As a response to the influx of immigrants into public schools, previous research has reported that native students, and students from higher socioeconomic backgrounds, are more inclined to move to private schools with fewer immigrant students (Betts & Fairlie, 2003; Rangvid, 2010). Therefore, how the proportion of immigrants in a school, the school's public/private status, and the overall socioeconomic status of the school reflect on immigrant student performance is of particular interest.

Participation in after-school extracurricular activities generally results in higher levels of academic achievement (Fredricks & Eccles, 2010), school belongingness (Brown & Evans, 2002), and intrinsic motivation (Vandell et al., 2005) among students from various ethnic backgrounds. Extracurricular activities may be especially helpful for students from underprivileged populations (Blomfield & Barber, 2011; Im et al., 2016). It is theorized that, due to their lower socioeconomic background, immigrant students can benefit substantially from extracurricular activities, especially in terms of increased academic performance (Camacho & Fuligni, 2015). Though less likely to participate in extracurricular activities, research suggests that 1G students tend to benefit more than the other immigrant groups by exhibiting higher resultant levels of academic achievement (Camacho & Fuligni, 2015). In the PISA 2018 survey, school principals were asked to report the extra-curricular activities offered to 15-year-old students. In our analyses, we used the index of creative extra-curricular activities at school (CREACTIV), which is the sum of the following activities that students participated in school: (1) art club or art activities; (2) school play or school musical; (3) band, orchestra, or choir. Such activities at school are expected to increase immigrant students' school belongingness, motivation, and thus their academic performance, as explained above.

A school's "shortage of educational materials" as a "hard" educational resource and a school's "shortage of educational staff" as a "soft" educational resource in the PISA 2018 survey (OECD, 2018) may reflect a school's potential to provide general support and educational opportunities to the immigrant students. Therefore, the current study also includes these variables.

1.3.3 School's equity-oriented policies

It is challenging for most schools to develop policies and practices to prevent or reduce discrimination, racism, and socio-cultural tensions, and to foster positive attitudes and behaviors toward immigrant students (Celeste et al., 2019; Vedder et al., 2006). The adjustment of immigrant students to a new educational context can be promoted through preparatory programs before transferring to regular classes, additional instruction in specific subjects, and supportive and cooperative learning environments (Makarova & Birman, 2016; Vedder et al., 2006; Warikoo & Carter, 2009). However, the separation of immigrant students in preparatory programs or targeted groups may be perceived by some immigrants as a segregating factor, causing resentment, anxiety, and depression, and exacerbating

discrimination (Allen, 2006). Research suggests that segregating school policies and practices that either reject or ignore diversity were associated with persistent gaps in the learning outcomes of immigrant students (Celeste et al., 2019). It is, therefore, essential to understand if specific school policies reduce or exacerbate inequalities to promote the educational outcomes of immigrant students.

2 The current study

Most studies have focused on the settlement of immigrant students and the extent to which socio-demographic factors were associated with their academic achievement. For instance, Pivovarova and Powers's (2019) secondary analysis of the United States PISA data using student background characteristics and school contextual factors shows that the achievement gap between first-generation students and their second and third-plus generation peers disappears. Results suggest that what the researchers observed as generational differences in achievement are more likely to be gender, racial, and socioeconomic gaps (Pivovarova & Powers, 2019). In addition, Azzolini et al. (2012) highlighted that both first- and second-generation immigrant students underperform natives in both Italy and Spain and that SES background and language skills contribute to an explanation of achievement gaps.

A substantial body of research has been conducted on the academic achievement and educational outcomes of immigrant children (Azzolini et al., 2012; Duong et al., 2016; Pew Research Center, 2015; Portes & Zhou, 1993). However, most were conducted with a decade or more old data. There is considerable variation in outcomes among immigrant groups of both generations associated with race/ethnicity, family background, and the characteristics of immigrant destinations. In addition, very little research has explored the psychosocial predictors of the achievement gap between 1 and 2G students.

The present study contributes to and extends previous work by providing a more nuanced analysis of settlement data as a moderating effect (1G and 2G). This study demonstrates the features of schools as an essential aspect of the context of reception for 1G and 2G. This study also functions to disentangle the effects and processes operating within and between schools as they apply to immigrant student experiences and outcomes. For example, how student attributes and experiences (e.g., gender and individual socioeconomic status) reflect upon their comparative academic performance within schools; and how school policies (e.g., school type and the opportunity for creative extracurricular activities) reflect upon comparative school performance is discerned in this study. In general, the purpose of this study is to identify the critical antecedents of the 1G and 2G students' academic performance to inform school practice and policy. Based on the review of the literature, the following research questions are posed:

RQ1: To what extent does the performance of immigrant students in mathematics, science, and reading vary between schools and countries?

RQ2: (a) What are the within-school, between-school, and between-country antecedents of the PISA mathematics performance of immigrant students and (b) what antecedents might be especially relevant to 1G students?

RQ3: (a) What are within-school, between-school, and between-country antecedents of the PISA science performance of immigrant students, and (b) what antecedents might be especially relevant to 1G students?

RQ4: (a) What are within-school, between-school, and between-country antecedents of the PISA reading performance of immigrant students, and (b) what antecedents might be especially relevant to 1G students?

RQ5: How do the antecedents for mathematics, science, and reading ability of immigrant students compare?

3 Data sources

This study compiled data from the most recent PISA 2018 cycle made available on the OECD website. PISA is an international survey that has been conducted every 3 years since 2000. PISA assesses 15-year-old students' science, math, and reading achievement scores, their various attitudes, behaviors, demographics, and other relevant contextual data from their parents and schools. For the current study, both student and school datasets were merged and analyzed. However, only students identified as 1G and 2G were included.

Each country participating in PISA had the option to have students and schools (via school principals) complete specific questions that measured the demographics, social experience of students, and general school policy toward immigrant student integration. Because all survey questions were not obligatory, different countries opted to exclude questions relevant to the current study, such as those about the immigrant status of students. After removing such countries and implementing case-wise deletion, the total student sample size consisted of 11,582 students from 534 schools located in 20 different countries. A total of 5840 students (50.4%) identified as 2G students while 5742 students (49.6%) identified as 1G immigrant students. All schools included in the current study catered to a mix of at least ten 1G and 2G immigrant students to enable the examination of the effects of such status within and between schools.

To account for previous research that has found systemic economic differences in educational opportunities between countries (Montagnier and Wirthmann, 2011), a third level, the country level, was included in all models. Furthermore, it has been estimated that level three effects are relatively stable if more than 15 or 20 countries were available (Stegmueller, 2013), suggesting that the inclusion of this level was statistically viable.

3.1 Variables

Three separate stepwise multilevel models were used to examine the effect of immigrant students' attributes and experience, and school provisions and policy

on immigrant students' academic achievement in the 2018 PISA Mathematics, Science, and Reading. The average of the five plausible values of students' math, science, and reading scores were used as dependent variables in this study; consequently, an examination of the unique contribution of sets of variables in the step-wise models at each of the eight steps for each subject was possible. The independent variables used at the country, school, and student levels are described below.

3.1.1 Country-level variables

As stated, there are inequalities in educational systems among countries related to socioeconomic characteristics (Montagnier and Wirthmann, 2011). A prominent indicator of a country's socioeconomic level is its 2018 GDP per-capita score taken from the World Bank (2020), which each of the three models of subject outcomes at the country level included.

3.1.2 School-level variables

Four school-level provision-related variables were incorporated in the current study. School type (PISA code, SCHLTYPE; 1=Private; 2=Public), the number of creative extracurricular activities made available to students (CREACTIV; 0=none, 1, 2, 3), shortage of educational material (EDUSHORT; Warm's likelihood estimate scale, WLE, based on item-response theory, IRT, generated scale), and shortage of educational staff (STAFFSHORT; WLE) were included.

The following seven student-level variables related to student attributes and experience were aggregated to the school level to explore the general effect of these factors between schools: gender (ST004D01T; 1=female, 2=male); economic, social, and cultural status (ESCS; composite score); parents' emotional support perceived by the student (EMOSUPS; WLE); perceived teacher's interest (by the student) (TEACHINT; WLE), teachers' adaptation of instruction to the needs, knowledge, and difficulties of students (perceived by the student) (ADAPTIVITY; WLE); student experience of being bullied (BEINGBULLIED; WLE); immigration status (IMMIG; 1=2G, 2=1G; with values closer to 2.00 representing a prevalence of 1G immigrants in a school; with all values greater than 1.00 and less than 2.00).

Five immigrant school policy-related variables were used in this study to explore the role of specific equity-oriented policy implementations for immigrant students: (1) Students attend regular classes and received additional periods of instruction (SC150Q01IA). (2) Before transferring to regular classes, students receive targeted preparatory program (SC150Q02IA). (3) Before transferring to regular classes, the instruction is given in specific school subjects (SC150Q03IA). (4) These students receive some instruction in their heritage language (SC150Q04IA); (5) Class size is reduced to cater to the special needs of these students (SC150Q05IA). Response options for all five questions all were 1=No, or 2=Yes.

3.1.3 Student-level variables

The same seven school-level variables relating to student attributes and experience that were aggregated to the school level were included in the current study at the within-school level: gender (ST004D01T), ESCS, parents' emotional support perceived by the student (EMOSUPS), perceived teacher's interest/enthusiasm (by the student) (TEACH-INT, WLE), the adaptation of instruction (ADAPTIVITY), student's experience of being bullied (BEINGBULLIED; WLE), and immigration status (IMMIG). To examine the effects of these seven variables on the outcomes of interest, all schools included in the analysis exhibited some degree of within-school variance for these variables.

3.2 Data adjustments

Except for the dichotomous variables, gender, immigration status, and school type, all variables were standardized and then mean-centered (see Table 1 for descriptive statistics for final adjusted data). This standardization was done to enable a comparison of specific fixed effects for each subject. As illustrated in Table 1, all variables exhibited acceptable levels of skewness under $|2.00|$ (Schmider et al., 2010); therefore, normalization was not deemed necessary.

3.3 Analysis

The analysis was undertaken with the assistance of the open-source software, R (R Core Team, 2019), making use of the lme4 (linear mixed-effects) package's (Bates et al., 2015) lmer function. Analyses accounted for the three-level hierarchical structure of the data with students nested in schools, and schools nested in countries. For RQ1, for each subject area, an initial exploration of the variance components and associated intra-class correlations (ICCs) for immigrant students' math, science, and reading was undertaken. RQ1 also involved an additional examination of the within- and between-school correlations between the three academic outcomes (Math and Science, Science and Reading, Math and Reading). This was undertaken with the R lavaan package's (Rosseel, 2012) cfa function. For RQ2a, RQ3a, and RQ4a, an analysis of the aforementioned student-, school-, and country-level variables as fixed effects were undertaken using the lmer function.

Variables were entered into each of the three subject-specific models in a step-wise manner to enable an assessment of whether the inclusion of sets of variables provided statistically significant contributions (through an examination of changes in deviance). For RQ2b, RQ3b, and RQ4b, to explore whether specific factors might be especially relevant to enhancing 1G immigrant student outcomes, interaction effects were also examined. In model 7, statistically significant student-level direct effects were modeled as interactions with immigrant status¹ and, in

¹ Though, the interaction effects between gender and immigration status were not explored due to lack of variance of all possible gender-immigration status combinations within schools: i.e., not all schools had male-1G, male-2G, female-1G, and female-2G students, so comprehensive examination of interaction effects, or by modelling variables via dummy coding scheme, was not possible.

Table 1 Descriptive statistics for variables of interest

Variable	Abbreviation	M	SD	Skew	Coding scheme/min to max
Level 1 (within school; student ability; N = 11,582)					
Student Math Ability	PV1-5MATH	510.80	93.76	-0.10	195.3 to 827.3
Student Reading Ability	PV1-5READ	499.48	104.29	-0.18	66.19 to 802.78
Student Science Ability	PV1-5SCIE	502.00	95.26	-0.09	212.90 to 812.00
Level 1 (within school; student experience; N = 11,582)					
Gender	ST004D00IT	1.51	0.50	-0.05	1 = female; 2 = male
PISA Index of economic, social, and cultural status	ESCS	0.00	1.00	-0.45	-6.10 to 3.37
Parents' emotional support perceived by a student (WLE)	EMOSUPS	0.00	1.00	-0.042	-2.39 to 1.08
Perceived teacher's interest [by a student] (WLE)	TEACHINT	0.00	1.00	-0.06	-2.39 to 1.72
Adaptation of instruction (WLE)	ADAPTIVITY	0.00	1.00	-0.03	-2.40 to 1.97
Student's experience of being bullied (WLE)	BEINGBULLIED	0.00	1.00	0.90	-0.89 to 3.58
Index immigration status	IMMIG	0.00	0.50	0.02	1 = 2G; 2 = 1G
Level 2 (between school; school provisions; N = 534)					
School type (public)	SCHLTYPE	1.52	0.50	-0.06	1 = private; 2 = public
Creative extracurricular activities	CREACTIV	0.00	1.00	-1.21	-2.75 to 0.72
Shortage of educational material	EDUSHORT	0.00	1.00	0.89	-1.53 to 3.48
Shortage of educational staff	STAFFSHORT	0.00	1.00	0.65	-1.50 to 3.99
Level 2 (between school; school's equity-oriented policies; N = 534)					
Students attend regular classes and receive additional periods of instruction	SC150Q01IA	1.34	0.47	0.70	1 = No; 2 = Yes
Before transferring to regular classes, students receive targeted preparatory program	SC150Q02IA	1.59	0.49	-0.37	1 = No; 2 = Yes
Before transferring to regular classes, instruction given in specific school subjects	SC150Q03IA	1.85	0.36	-1.97	1 = No; 2 = Yes
These students receive some instruction in their heritage language	SC150Q04IA	1.81	0.40	-1.55	1 = No; 2 = Yes
Class size is reduced to cater to the special needs of these students	SC150Q05IA	1.62	0.48	-0.51	1 = No; 2 = Yes
Level 3 (between country; gross domestic product; N = 20)					
Gross domestic product per capita (z)	GDP per capita	0.00	1.00	0.56	-1.28 to 1.87

WLE = Warm's likelihood estimate based on PISA item-response theory scaled scores; private schools coded as inclusive of private-public partnership schools; Math, Reading, and Science ability for each student average of first five plausible values

model 8, significant school-level direct effects were modeled as interactions with mean school immigration status.

All models at each step converged successfully. All models used the maximum likelihood (ML) estimation. Given the trend toward more strict assessments of statistical significance (Benjamin et al., 2018), and the relatively large sample sizes associated with the current study, a threshold of $p < 0.01$ is applied when interpreting the substantiveness of independent and control variables across each of the three models. However, instances of statistical significance, specifically $p < 0.05$, for the same variable across multiple subjects will be considered of interest.

4 Results

4.1 RQ1: Country- and school-level variation in math, science, and reading outcomes of immigrant students

Table 2 presents the variance components and intraclass correlation coefficients for the PISA 2018 math, science, and reading scores for the immigrant cohort.

At the within-school level, the correlation coefficients between immigrants' (1) mathematics and science performance was $r = 0.829$, $p < 0.001$; (2) science and reading performance was $r = 0.872$, $p < 0.001$; and (3) mathematics and reading was $r = 0.790$, $p < 0.001$.

At the between-school level, the correlation coefficients between immigrants' (1) mathematics and science performance was $r = 0.951$, $p < 0.001$; (2) science and reading performance was $r = 0.951$, $p < 0.001$; and (3) mathematics and reading was $r = 0.929$, $p < 0.001$.

Table 2 Variance components for math, science, and reading null models

Statistic	Estimate
Mathematics	
Intercept (country)	2062.26
Intercept (school)	2508.21
Residual	4743.28
ICC for country	0.22
ICC for school	0.27
Science	
Intercept (country)	1990.15
Intercept (school)	2462.88
Residual	5082.43
ICC for country	0.21
ICC for school	0.26
Reading	
Intercept (country)	1718.76
Intercept (school)	2970.33
Residual	6492.21
ICC for country	0.15
ICC for school	0.27

4.2 RQ2: Understanding the drivers of math, science, and reading outcomes of the immigrant students

Tables 3, 4, and 5 present the results for mixed-effects models for math, science, and reading, respectively.

4.3 Summary of results

4.3.1 RQ1: Variation in immigrant students' PISA math, science, and reading performance between countries and schools

For RQ1, to what degree do the ability of math, science, and reading students vary between schools and countries, results were quite consistent across subject areas. Country-level intra-class correlations for PISA 2018 math, science, and reading ability were 0.22, 0.21, and 0.15, respectively. School-level ICCs for math, science, and reading ability were 0.27, 0.26, and 0.27, respectively. All values suggest substantive school- and country-level effects.

Correlations between the three outcomes within schools were very strong across all three subject combinations at Sci-Math ($r=0.829$, $p<0.001$), Sci-Read ($r=0.872$, $p<0.001$), and Math-Read ($r=0.790$, $p<0.001$). However, between schools, the correlations were even stronger at Sci-Math ($r=0.951$, $p<0.001$), Sci-Read ($r=0.969$, $p<0.001$), and Math-Read ($r=0.929$, $p<0.001$).

4.3.2 RQ2a: Predictors of immigrant students' math performance

RQ2a explores the antecedents of immigrant students' mathematics ability. Results from model 6 (inclusive of all direct effects) suggest that, except for immigration status and parents' emotional support, all within-school variables provided a statistically significant contribution ($p<0.01$) to immigrants the math ability of students. Being male and of a higher ESCS appeared to have substantive positive effects on within-school differences in math ability, while student experience of bullying appeared to have a substantive negative effect. The adaption of class instruction, the perceived interest of teachers, and parental emotional support experienced by immigrants also appear to have positive and statistically significant effects, although less substantive.

Results from model 6 suggest that school provisions have a substantive effect on the between-school math ability of the immigrant cohort. Specifically, the number of creative extracurricular activities had a positive and statistically significant effect on immigrant students' math ability.

Results from model 6 also suggest that the mean school ESCS of the immigrant students appears to have a considerable positive impact on the students' mathematics ability. Conversely, the general prevalence of school bullying experienced by the immigrant group, and the proportion of 1G students in the school appears to have substantive adverse effects on immigrant students' math performance.

The specialized immigrant policies of schools had no substantive effect on math performance. Similarly, the inclusion of each country's GDP per capita had no further substantive effect on immigrant student math outcomes between countries in model 6.

4.3.3 RQ2b: Predictors of specific relevance to 1G immigrant student's math performance

To explore the particular relevance of the within-school variables for 1G students, model 7 tests an additional five interaction effects. Results suggest that, when it comes to mathematics performance, emotional support from parents may be particularly useful for 1G immigrant students' mathematics outcomes. Model 8 explores four level-2 interaction effects; however, no substantive effects were found.

4.4 Summary of the math performance of immigrant students

In summary, within schools, immigrant students' math scores appear to be driven by being male, having higher ESCS, experiencing less bullying, the adaption of class instruction, and the perceived interest of teachers. At the between-school level, the immigrant students' average ESCS, the overall reduction in bullying, and the amount of creative extracurricular activities appear to enhance the overall school math performance of the immigrant students. Finally, emotional support from parents also appears to be of particular relevance to 1G immigrant students' performance in mathematics.

4.4.1 RQ3a: Predictors of immigrant students' science performance

RQ2b explores the antecedents of immigrant students' science ability. Very similar to the results for mathematics, results from model 6 suggest that, except for immigration status, all within-school variables provided a statistically significant contribution to immigrant students' science ability. Being of a higher ESCS and male appeared to have substantive positive effects on within-school differences in science ability, while student experience of bullying appeared to have a substantive negative effect. The perceived interest of teachers, the adaption of class instruction, and parental emotional support experienced by immigrants also seem to have positive statistically significant effects, although less substantive.

Results from model 6 also suggest that school provisions have a substantive effect on the between-school science ability of the immigrant cohort. Similarly, the number of creative extracurricular activities had a positive and statistically significant effect on immigrant student science ability.

Aggregated student attributes and experiences in model 6 provide for substantive effects on between-school outcomes. The mean school ESCS of the immigrant students appears to have a large positive effect on the students' science ability. Conversely, the proportion of 1G students in the school and the overall prevalence of

Table 3 Stepwise mixed effects model for immigrant students' mathematics ability

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Intercepts	490.90***(45.86)	463.79***(45.22)	487.13***(34.33)	536.66***(20.16)	510.25***(17.86)	510.78***(17.98)	510.84***(18.01)	510.62***(18.01)
Level 1 (Student attributes and experience)								
Gender (male focal group)		16.88***(13.02)	16.86***(13.01)	17.05***(13.11)	17.05***(13.11)	17.05***(13.11)	17.04***(13.11)	17.05***(13.11)
PISA Index of economic, social, and cultural status (ESCS)		14.10***(15.97)	13.93***(15.77)	11.80***(13.10)	11.80***(13.10)	11.80***(13.10) [‡]	9.52***(4.28)	11.80***(13.10)
Parents' emotional support perceived by a student (WLE)		1.56*(2.28)	1.55*(2.26)	1.61*(2.35)	1.61*(2.35)	1.61*(2.35) [‡]	-4.26*(-1.98)	1.61*(2.35)
Perceived teacher's interest [by a student] (WLE)		3.43***(4.45)	3.37***(4.37)	3.33***(4.30)	3.33***(4.30)	3.33***(4.30) [‡]	7.84***(3.29)	3.33***(4.30)
Adaptation of instruction (WLE)		4.21***(5.55)	4.21***(5.55)	4.21***(5.30)	4.21***(5.53)	4.21***(5.53) [‡]	0.90 ^{ns} (0.38)	4.21***(5.53)
Student's experience of being bullied (WLE)		-6.12***(-9.22)	-6.13***(-9.24)	-5.94***(-8.92)	-5.94***(-8.92)	-5.94***(-8.92) [‡]	-3.27 ^{ns} (-1.57)	-5.94***(-8.92)
Immigration status (IG focal group)		2.09 ^{ns} (1.48)	1.89 ^{ns} (1.34)	2.27 ^{ns} (1.60)	2.27 ^{ns} (1.60)	2.27 ^{ns} (1.60)	2.38 ^{ns} (1.67)	2.27 ^{ns} (1.60)
Level 1 (Immigration status interaction effects)								
ESCS × Immigration status							1.52 ^{ns} (1.10)	
Parents' emotional support perceived by student × Immigration status							3.92***(2.90)	
Perceived teacher's interest × Immigration status							-3.04*(-2.01)	

Table 3 (continued)

Variable	Model 1: NULL Coefficient (<i>t</i>)	Model 2 Coefficient (<i>t</i>)	Model 3 Coefficient (<i>t</i>)	Model 4 Coefficient (<i>t</i>)	Model 5 Coefficient (<i>t</i>)	Model 6 Coefficient (<i>t</i>)	Model 7 Coefficient (<i>t</i>)	Model 8 Coefficient (<i>t</i>)
Adaptation of instruction × Immigration status							2.25 ^{ns} (1.50)	
Student's experience of being bullied × Immigration status							-1.75 ^{ns} (-1.34)	
Level 2 (School provisions)								
School type (public)			-12.70 ^{ns} (-1.93)	5.82 ^{ns} (1.05)	6.61 ^{ns} (1.19)	6.56 ^{ns} (1.18)	6.68 ^{ns} (1.20)	6.78 ^{ns} (1.22)
Creative extracurricular activities			9.98 ^{***} (4.08)	6.55 ^{***} (3.50)	7.54 ^{***} (3.74)	7.47 ^{***} (3.70) [#]	7.36 ^{***} (3.65)	7.47 ^{ns} (0.64)
Shortage of educational material			-1.19 ^{ns} (-0.43)	2.43 ^{ns} (1.11)	2.59 ^{ns} (1.17)	2.57 ^{ns} (1.16)	2.61 ^{ns} (1.18)	2.76 ^{ns} (1.23)
Shortage of educational staff			-7.90 ^{***} (-2.88)	-4.95 [*] (-2.19)	-5.04 [*] (-2.27)	-5.01 [*] (-2.26) [#]	-5.04 [*] (-2.27)	4.94 ^{ns} (0.42)
Level 2 (Aggregated student attributes and experience)								
Gender (male focal group) (<i>M</i>)				-11.53 ^{ns} (-0.87)	-12.74 ^{ns} (-0.97)	-13.17 ^{ns} (-1.00)	-13.01 ^{ns} (-0.99)	-11.76 ^{ns} (-0.89)
PISA Index of economic, social, and cultural status (ESCS) (<i>M</i>)				58.43 ^{***} (15.05)	57.31 ^{***} (14.72)	57.36 ^{***} (14.76) [#]	57.29 ^{***} (14.75)	43.61 [*] (2.38)
Parents' emotional support perceived by a student (<i>M</i>)				0.26 ^{ns} (0.04)	0.40 ^{ns} (0.06)	0.39 ^{ns} (0.06)	0.54 ^{ns} (0.08)	1.65 ^{ns} (0.26)
Perceived teacher's interest [by a student] (<i>M</i>)				3.59 ^{ns} (0.54)	2.68 ^{ns} (0.40)	2.59 ^{ns} (0.39)	2.64 ^{ns} (0.39)	2.71 ^{ns} (0.41)
Adaptation of instruction (<i>M</i>)				-0.09 ^{ns} (-0.01)	1.76 ^{ns} (0.24)	2.02 ^{ns} (0.28)	2.00 ^{ns} (0.28)	1.81 ^{ns} (0.25)

Table 3 (continued)

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Student's experience of being bullied (M)				-29.97***(-4.73)	-27.65***(-4.33)	-27.51***(-4.31) [#]	-27.51***(-4.31)	4.58 ^{ns} (0.13)
Immigration status (1G focal group) (M)				-41.83***(-4.56)	-38.63***(-4.19)	-38.55***(-4.19)	-38.95***(-4.24)	-39.83***(-4.31)
Level 2 (School specialized immigrant student policy)								
Students attend regular classes and receive additional periods of instruction					2.54 ^{ns} (0.60)	2.45 ^{ns} (0.58)	2.50 ^{ns} (0.60)	2.41 ^{ns} (0.58)
Before transferring to regular classes, students receive targeted preparatory program					4.53 ^{ns} (1.05)	4.54 ^{ns} (1.05)	4.44 ^{ns} (1.03)	5.05 ^{ns} (1.17)
Before transferring to regular classes, the instruction given in specific school subjects					0.12 ^{ns} (0.02)	0.21 ^{ns} (0.03)	0.34 ^{ns} (0.05)	-0.25 ^{ns} (-0.04)
These students receive some instruction in their heritage language					0.90 ^{ns} (0.16)	0.84 ^{ns} (0.15)	0.70 ^{ns} (0.13)	0.76 ^{ns} (0.14)
Class size is reduced to cater to the special needs of these students					5.78 ^{ns} (1.40)	5.82 ^{ns} (1.41)	5.81 ^{ns} (1.41)	5.32 ^{ns} (1.29)
Level 2 (School mean immigration status interaction effects)								
Creative extracurricular activities X Immigration status								-0.24 ^{ns} (-0.03)

Table 3 (continued)

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Shortage of educational staff × Immigration status								-6.64 ^{ns} (-0.85)
ESCS(M) × Immigration status								8.85 ^{ns} (0.74)
Student's experience of being bullied (M) × Immigration status								-21.69 ^{ns} (-0.89)
Level 3 (Country covariate)								
GDP per capita of the country						-13.43 ^{ns} (-1.48)	-13.43 ^{ns} (-1.48)	-13.42 ^{ns} (-1.48)
Model deviance comparisons across models								
Deviance M1 - deviance M2	132,221.9 - 132,221.9	132,221.9 - 131,589.6	131,589.6 - 131,316.4	131,549.6 - 131,324.1	131,324.1 - 131,316.4	131,316.4 - 131,314.3	131,314.3 - 131,296.6	131,314.3 - 131,311.9
Reduction in deviance (df) statistical significance								
Reduction (df)		632.3(7)***	40.0(4)***	225.5(7)***	7.7(5) ^{ns}	2.1(1) ^{ns}	17.7(5)**	2.4(4) ^{ns}

M = school mean; † denotes level 1 interaction effect to be tested in model 7; ‡ denotes level 2 interaction effect to be tested in model 8; 20 countries, 534 schools, 11,582 students, average school size = 21.69 students; see Appendix for breakdown by country; M = school mean; df = degrees of freedom; *p < 0.05, **p < 0.01, ***p < 0.001, ns = not statistically significant

school bullying experienced by the immigrant students in school appears to have substantive adverse effects on the immigrant students' science performance.

The inclusion of specialized immigrant policies in model 6 provided no substantive effect ($p < 0.01$) beyond the effect of other between-school variables in the model. In addition, the inclusion of each country's GDP per capita had no further substantive effect on immigrant student science outcomes in model 6.

4.4.2 RQ3b: Predictors of specific relevance to 1G immigrant students' science performance

To explore the particular relevance of the within-school variables for 1G students, model 7 tests an additional five interaction effects. Results suggest that being of higher socioeconomic status is especially useful to 1G students' outcomes in mathematics. Model 8 explores four level-2 interaction effects; however, no substantive effects were found.

4.5 Summary of the science performance of immigrant students

In summary, within schools, immigrant students' science scores appear to be driven by having higher ESCS, being male, experiencing less bullying, the perceived interest and enthusiasm of teachers, the adaptation of class instruction, and the experience of emotional support of parents. At the between-school level, students' extracurricular opportunities, average ESCS, overall reduction in bullying, and predominance of 2G immigrants appear to enhance the average school science performance of the immigrant students.

4.5.1 Q4a: Predictors of immigrant students' reading performance

RQ4a explores the antecedents of immigrant students' reading ability. For reading, model 6, all within-school variables provided a statistically significant contribution to immigrant students' reading ability. Being female and of a higher ESCS appeared to have substantive positive effects on within-school differences in reading ability, while student experience of bullying and 1G status appeared to have a substantive negative effect. The perceived interest of teachers, the adaptation of class instruction, and parental emotional support experienced by immigrants also appear to have positive and statistically significant effects, although less substantive.

Results from model 6 also suggest that school provisions have a substantive effect on the between-school reading ability of the immigrant cohort. Specifically, the number of creative extracurricular activities had a positive and statistically significant effect on immigrant student reading ability, while staff shortages tended to have a negative and statistically significant effect on the school-level reading performance.

In model 6, there appear to be substantive effects as a consequence of aggregated student experience. The mean school ESCS of the immigrant students appears to have a substantial positive effect on the reading ability of students. Conversely, the

Table 4 Stepwise mixed effects model for immigrant students' science ability

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Intercepts	490.90***(45.86)	476.16***(47.03)	503.33***(36.56)	545.15***(21.01)	508.77***(18.40)	509.26***(18.50)	509.32***(18.51)	503.69***(11.48)
Level 1 (Student attributes and experience)								
Gender (male focal group)		7.46***(5.53)	7.43***(5.51)	7.65***(5.65)	7.65***(5.65)	7.65***(5.65)	7.66***(5.66)	7.65***(5.65)
PISA Index of economic, social, and cultural status (ESCS)		13.95***(15.21)	13.77***(15.01)	11.36***(12.12)	11.36***(12.12)	11.36***(12.12) [‡]	5.84*(2.53)	11.36***(12.12)
Parents' emotional support perceived by a student (WLE)		2.79***(3.91)	2.77***(3.90)	2.86***(4.00)	2.86***(4.00)	2.86***(4.00) [‡]	-0.13 ^{ns} (-0.06)	2.86***(4.00)
Perceived teacher's interest [by a student] (WLE)		3.73***(4.65)	3.66***(4.56)	3.61***(4.47)	3.61***(4.47)	3.61***(4.47) [‡]	8.60***(3.47)	3.61***(4.47)
Adaptation of 'instruction (WLE)		3.57***(4.52)	3.57***(5.53)	3.56***(4.49)	3.56***(4.49)	3.56***(4.49) [‡]	-0.79 ^{ns} (-0.32)	3.56***(4.49)
Student's experience of being bullied (WLE)		-6.70***(-9.70)	-6.72***(-9.73)	-6.51***(-9.39)	-6.51***(-9.39)	-6.51***(-9.39) [‡]	-4.55 ^{ns} (-2.10)	-6.51***(-9.39)
Immigration status (IG focal group)		-1.66 ^{ns} (-1.13)	-1.88 ^{ns} (-1.28)	-1.59 ^{ns} (-1.08)	-1.59 ^{ns} (-1.08)	-1.59 ^{ns} (-1.08)	-1.44 ^{ns} (-0.97)	-1.59 ^{ns} (-1.08)
Level 1 (Immigration status interaction effects)								
ESCS × Immigration status							3.73***(2.60)	
Parents' emotional support perceived by student × Immigration status							2.01 ^{ns} (1.43)	
Perceived teacher's interest × Immigration status							-3.34 ^{ns} (-2.12)	
Adaptation of 'instruction × Immigration status							2.94 ^{ns} (1.89)	

Table 4 (continued)

Variable	Model 1: NULL Coefficient (<i>t</i>)	Model 2 Coefficient (<i>t</i>)	Model 3 Coefficient (<i>t</i>)	Model 4 Coefficient (<i>t</i>)	Model 5 Coefficient (<i>t</i>)	Model 6 Coefficient (<i>t</i>)	Model 7 Coefficient (<i>t</i>)	Model 8 Coefficient (<i>t</i>)
Student's experience of being bullied × Immigration status							-1.25 ^{ns} (-0.93)	
Level 2 (School provisions)								
School type (public)			-14.94 [*] (-2.32)	3.59 ^{ns} (0.66)	5.31 ^{ns} (0.98)	5.28 ^{ns} (0.98)	5.39 ^{ns} (1.00)	5.76 ^{ns} (1.07)
Creative extracurricular activities			10.64 ^{***} (4.43)	7.40 ^{***} (3.75)	7.95 ^{***} (4.05)	7.90 ^{***} (4.03) [‡]	7.77 ^{***} (3.97)	-9.43 ^{ns} (-0.83)
Shortage of educational material			-1.08 ^{ns} (-0.40)	2.63 ^{ns} (1.20)	2.74 ^{ns} (1.27)	2.71 ^{ns} (1.26)	2.82 ^{ns} (1.30)	3.10 ^{ns} (1.43)
Shortage of educational staff			-8.36 ^{**} (-3.11)	-5.28 [*] (-2.42)	-5.45 [*] (-2.53)	-5.42 [*] (-2.51) [‡]	-5.47 [*] (-2.53)	0.63 ^{ns} (0.05)
Level 2 (Aggregated student attributes and experience)								
Gender (male focal group) (<i>M</i>)				-14.11 ^{ns} (-1.08)	-15.01 ^{ns} (-1.17)	-15.39 ^{ns} (-1.20)	-15.17 ^{ns} (-1.18)	-14.32 ^{ns} (-1.11)
PISA Index of economic, social, and cultural status (ECS) (<i>M</i>)				58.40 ^{***} (15.30)	57.00 ^{***} (15.01)	57.06 ^{***} (15.04) [‡]	56.89 ^{***} (15.01)	45.30 [*] (2.55)
Parents' emotional support perceived by a student (<i>M</i>)				-1.27 ^{ns} (-0.20)	-0.76 ^{ns} (-0.12)	-0.76 ^{ns} (-0.12)	-0.59 ^{ns} (-0.09)	-0.09 ^{ns} (-0.01)
Perceived teacher's interest [by a student] (<i>M</i>)				3.79 ^{ns} (0.57)	2.71 ^{ns} (0.41)	2.63 ^{ns} (0.40)	2.62 ^{ns} (0.40)	2.77 ^{ns} (0.43)
Adaptation of instruction (<i>M</i>)				1.25 ^{ns} (0.18)	3.35 ^{ns} (0.48)	3.58 ^{ns} (0.51)	3.62 ^{ns} (0.52)	3.51 ^{ns} (0.50)
Student's experience of being bullied (<i>M</i>)				-28.50 ^{***} (-4.57)	-25.91 ^{***} (-4.16)	-25.76 ^{***} (-4.14) [‡]	-25.70 ^{***} (-4.13)	14.25 ^{ns} (0.40)

Table 4 (continued)

Variable	Model 1: NULL Coefficient (<i>t</i>)	Model 2 Coefficient (<i>t</i>)	Model 3 Coefficient (<i>t</i>)	Model 4 Coefficient (<i>t</i>)	Model 5 Coefficient (<i>t</i>)	Model 6 Coefficient (<i>t</i>)	Model 7 Coefficient (<i>t</i>)	Model 8 Coefficient (<i>t</i>)
Immigration status (IG focal group) (<i>M</i>)				-33.84***(-3.76)	-28.79***(-3.21)	-28.75***(-3.21)	-29.36***(-3.28)	-26.88**(-1.10)
Level 2 (School specialized immigrant student policy)								
Students attend regular classes and receive additional periods of instruction					2.07***(0.51)	2.00***(0.49)	1.99***(0.49)	1.87***(0.46)
Before transferring to regular classes, stu- dents receive targeted preparatory program					10.41***(2.47)	10.42***(2.48)**	10.42***(2.48)	14.45***(0.67)
Before transferring to regular classes, the instruction given in specific school subjects					-2.01***(-0.33)	-1.93***(-0.32)	-1.86***(-0.30)	-2.37***(-0.39)
These students receive some instruction in their heritage language					1.76***(0.33)	1.72***(0.32)	1.58***(0.30)	1.32***(0.25)
Class size is reduced to cater to the special needs of these students					5.42***(1.35)	5.43***(1.35)	5.43***(1.35)	5.06***(1.26)
Level 2 (School mean immigration status interaction effects)								
Creative extracurricular activities × Immigra- tion status								11.51***(1.52)
Shortage of educational staff × Immigration status								-3.96***(-0.52)
ESCS(<i>M</i>) × Immigration status								7.50***(0.65)

Table 4 (continued)

Variable	Model 1: NULL Coefficient (<i>t</i>)	Model 2 Coefficient (<i>t</i>)	Model 3 Coefficient (<i>t</i>)	Model 4 Coefficient (<i>t</i>)	Model 5 Coefficient (<i>t</i>)	Model 6 Coefficient (<i>t</i>)	Model 7 Coefficient (<i>t</i>)	Model 8 Coefficient (<i>t</i>)
Student's experience of being bullied (<i>M</i>) × Immigration status								-27.10 ^{ns} (-1.14)
Targeted preparatory program × Immigration status								-2.12 ^{ns} (-0.15)
Level 3 (Country covariate)								
GDP per capita of the country						-11.28 ^{ns} (-1.34)	-11.26 ^{ns} (-1.34)	-11.12 ^{ns} (-1.31)
Model deviance comparisons across models								
Deviance M1 – deviance M2		132,979.7 – 132,463.3	132,463.3 – 132,416.5	132,416.5 – 132,188.3	132,188.3 – 132,172.2	132,172.2 – 132,170.4	132,170.4 – 132,153.5	132,170.4 – 132,165.8
Reduction in deviance (<i>df</i>) statistical significance								
Reduction (<i>df</i>) <i>p</i>		516.4(7)***	46.8(4)***	228.2(7)***	16.1(5)**	1.8(1) ^{ns}	16.9(5)**	4.6(5) ^{ns}

M = school mean; †denotes level 1 interaction effect to be tested in model 7; ‡denotes level 2 interaction effect to be tested in model 8; 20 countries, 534 schools, 11,582 students, average school size = 21.69 students; see [Appendix](#) for breakdown by country; *M* = school mean; *df* = degrees of freedom; **p* < 0.05, ***p* < 0.01, ****p* < 0.001, ns = not statistically significant

proportion of 1G students in the school and the overall prevalence of school bullying experienced by the immigrant group also appear to have substantive adverse effects on the immigrant students' average reading performance.

The specialized immigrant policies of schools had no substantive effects beyond the contribution of the other variables. Similarly, the addition of each country's GDP per capita had no further substantive effect on immigrant student science outcomes in model 6.

4.5.2 RQ4b: Predictors of specific relevance to 1G immigrant students' reading performance

To explore the particular relevance of the within-school variables for 1G students, model 7 tests an additional five interaction effects. Results suggest that, when it comes to performance in reading, 1G immigrant students of higher ESCS tend to experience particular advantages over their lower ESCS counterparts.

Model 8 explores four level-2 interaction effects; however, only one substantive effect was found. Results suggested that the effect of average school ESCS on average school reading performance was especially strong for schools with a higher proportion of 1G students.

4.6 Summary of the reading performance of immigrant students

In summary, within schools, the reading ability of immigrant students appears to be driven by being female, having a higher ESCS, experiencing less bullying, increased interest from teachers, status as a 2G immigrant, the adaptation of class instruction, and parental emotional support. At the between-school level, the immigrant students' opportunity to engage in extracurricular activities, supply of educational staff, average ESCS, an overall reduction in bullying, and predominance of 2G immigrants appear to enhance the average school reading performance of this cohort.

4.6.1 RQ5: Comparing results across the three subject areas

Table 6 provides a summary of the statistically significant results (including those for which $p < 0.05$) across subject areas. Results are taken from model 6 for each of the three subjects as these models include all direct effects. Within- and between-school interaction effects from models 7 and 8, respectively, are also included in Table 6 for reference in the lower two levels of the table.

The summary of results presented in Table 6 affords a high degree of consistency of effects across the three subject areas. The size of the within-school effects for gender, socioeconomics, and student experience of bullying appears to have consistently larger effects for all three academic outcomes. Similarly, effects related to school provisions, specifically the number of creative activities and shortage of staff, have very similar effects across the same three subject areas (with $p < 0.05$). In terms of aggregate student experiential effects, average ESCS, overall school bullying, and

Table 5 Stepwise mixed effects model for immigrant students' reading ability

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Intercepts	481.62***(48.35)	511.87***(52.11)	537.84***(37.89)	607.41***(22.04)	573.96***(19.48)	574.41***(19.56)	573.72***(19.60)	687.83***(5.43)
Level 1 (Student attributes and experience)								
Gender (male focal group)	-14.94***(-9.88)	-14.94***(-9.91)	-14.98***(-9.91)	-14.62***(-9.64)	-14.62***(-9.64)	-14.62***(-9.64)	-14.59***(-9.62)	-14.62***(-9.64)
PISA Index of economic, social, and cultural status (ESCS)	15.43***(15.03)	15.22***(14.83)	15.22***(14.83)	12.42***(11.81)	12.42***(11.81)	12.42***(11.81)†	3.51 ^{ns} (1.36)	12.42***(11.81)
Parents' emotional support perceived by a student (WLE)	3.52***(4.41)	3.51***(4.40)	3.51***(4.40)	3.58***(4.46)	3.58***(4.46)	3.58***(4.46)†	-1.91 ^{ns} (-0.76)	3.58***(4.46)
Perceived teacher's interest [by a student] (WLE)	5.08***(5.65)	5.00***(5.55)	5.00***(5.55)	4.96***(5.48)	4.96***(5.48)	4.96***(5.48)†	10.09***(3.64)	4.96***(5.48)
Adaptation of instruction (WLE)	4.36***(4.93)	4.36***(4.93)	4.36***(4.93)	4.37***(4.92)	4.37***(4.92)	4.37***(4.92)†	2.04 ^{ns} (0.74)	4.37***(4.92)
Student's experience of being bullied (WLE)	-8.03***(-10.37)	-8.06***(-10.41)	-8.06***(-10.41)	-7.80***(-10.04)	-7.80***(-10.04)	-7.80***(-10.04)†	-5.79 ^{ns} (-2.39)	-7.80***(-10.04)
Immigration status (IG focal group)	-4.60***(-2.80)	-4.90***(-2.98)	-4.90***(-2.98)	-4.47***(-2.70)	-4.47***(-2.70)	-4.47***(-2.70)	-4.26 ^{ns} (-2.57)	-4.47***(-2.70)
Level 1 (Immigration status interaction effects)								
ESCS x Immigration status							6.04***(3.76)	
Parents' emotional support perceived by student x Immigration status							3.67 ^{ns} (2.33)	
Perceived teacher's interest x Immigration status							-3.43 ^{ns} (-1.94)	
Adaptation of instruction x Immigration status							1.61 ^{ns} (0.92)	

Table 5 (continued)

Variable	Model 1: NULL Coefficient (<i>t</i>)	Model 2 Coefficient (<i>t</i>)	Model 3 Coefficient (<i>t</i>)	Model 4 Coefficient (<i>t</i>)	Model 5 Coefficient (<i>t</i>)	Model 6 Coefficient (<i>t</i>)	Model 7 Coefficient (<i>t</i>)	Model 8 Coefficient (<i>t</i>)
Student's experience of being bullied × Immigration status							-1.27 ^{ns} (-0.84)	
Level 2 (School provisions)								
School type (public)			-13.70 [*] (-1.99)	5.56 ^{ns} (0.96)	6.98 ^{ns} (1.21)	7.03 ^{ns} (1.22)	7.25 ^{ns} (1.26)	7.65 ^{ns} (1.34)
Creative extracurricular activities			13.00 ^{***} (5.05)	9.61 ^{***} (4.57)	10.33 ^{***} (4.93)	10.25 ^{***} (4.89) ^{††}	10.05 ^{***} (4.81)	-8.60 ^{ns} (-0.72)
Shortage of educational material			-2.68 ^{ns} (-0.92)	1.51 ^{ns} (0.65)	1.64 ^{ns} (0.71)	1.63 ^{ns} (0.71)	1.77 ^{ns} (0.77)	2.51 ^{ns} (1.09)
Shortage of educational staff			-8.77 ^{**} (-3.03)	-5.67 [*] (-2.44)	-5.95 ^{**} (-2.58)	-5.93 ^{**} (-2.57) ^{††}	-5.96 ^{**} (-2.60)	3.22 ^{ns} (0.26)
Level 2 (Aggregated student attributes and experience)								
Gender (male focal group) (<i>M</i>)				-28.54 [*] (-2.05)	-30.12 [*] (-2.19)	-30.50 [*] (-2.21) ^{††}	-29.98 [*] (-2.18)	-103.03 ^{ns} (-1.26)
PISA Index of economic, social, and cultural status (ESCS) (<i>M</i>)				62.99 ^{***} (15.46)	61.76 ^{***} (15.20)	61.79 ^{***} (15.22) ^{††}	61.49 ^{***} (15.19)	11.19 ^{ns} (0.59)
Parents' emotional support perceived by a student (<i>M</i>)				1.15 ^{ns} (0.17)	1.53 ^{ns} (0.23)	1.59 ^{ns} (0.24)	1.88 ^{ns} (0.28)	3.04 ^{ns} (0.46)
Perceived teacher's interest [by a student] (<i>M</i>)				2.31 ^{ns} (0.33)	0.83 ^{ns} (0.12)	0.79 ^{ns} (0.11)	0.83 ^{ns} (0.12)	0.73 ^{ns} (0.11)
Adaptation of instruction (<i>M</i>)				-0.24 ^{ns} (-0.03)	2.29 ^{ns} (0.30)	2.48 ^{ns} (0.33)	2.38 ^{ns} (0.32)	2.31 ^{ns} (0.31)

Table 5 (continued)

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Student's experience of being bullied (M)				-31.97***(-4.81)	-29.02***(-4.35)	-29.92***(-4.34) [#]	-28.97***(-4.36)	8.79 ^{ns} (0.22)
Immigration status (IG focal group) (M)				-39.52***(-4.12)	-34.77***(-3.62)	-34.81***(-3.63)	-35.50***(-3.72)	-117.19(-1.38)
Level 2 (School specialized immigrant student policy)								
Students attend regular classes and receive additional periods of instruction					5.40 ^{ns} (1.24)	5.31 ^{ns} (1.22)	5.30 ^{ns} (1.22)	4.86 ^{ns} (1.13)
Before transferring to regular classes, students receive targeted preparatory program					6.84 ^{ns} (1.52)	6.86 ^{ns} (1.53)	6.89 ^{ns} (1.54)	8.38 ^{ns} (1.88)
Before transferring to regular classes, the instruction given in specific school subjects					-0.50 ^{ns} (-0.08)	-0.44 ^{ns} (-0.07)	-0.35 ^{ns} (-0.05)	-1.15 ^{ns} (-0.18)
These students receive some instruction in their heritage language					-0.32 ^{ns} (-0.06)	-0.34 ^{ns} (-0.06)	-0.52 ^{ns} (-0.09)	-1.09 ^{ns} (-0.19)
Class size is reduced to cater to the special needs of these students					6.14 ^{ns} (1.43)	6.16 ^{ns} (1.44)	6.16 ^{ns} (1.44)	5.46 ^{ns} (1.28)
Level 2 (School mean immigration status interaction effects)								
Creative extracurricular activities×Immigration status								12.24 ^{ns} (1.53)

Table 5 (continued)

Variable	Model 1: NULL Coefficient (t)	Model 2 Coefficient (t)	Model 3 Coefficient (t)	Model 4 Coefficient (t)	Model 5 Coefficient (t)	Model 6 Coefficient (t)	Model 7 Coefficient (t)	Model 8 Coefficient (t)
Shortage of educational staff × Immigration status								-5.96 ^{ns} (-0.75)
Gender (male focal group) (M) × Immigration status								51.64 ^{ns} (0.93)
ESCS (M) × Immigration status								33.16 ^{**} (2.69)
Student's experience of being bullied (M) × Immigration status								-25.69 ^{ns} (-0.97)
Level 3 (Country covariate)								
GDP per capita of the country						-10.93 ^{ns} (-1.25)	-10.89 ^{ns} (-1.25)	-10.91 ^{ns} (-1.26)
Model deviance comparisons across models								
Deviance M1 – deviance M2	135,781.9	135,781.9 – 135,071.5	135,071.5 – 135,016.8	135,016.8 – 134,777.8	134,777.8 – 134,765.1	134,765.1 – 134,763.6	134,763.6 – 134,736.7	134,763.6 – 134,749.7
Reduction in deviance (df) statistical significance								
Reduction (df) p		710.4(7) ^{***}	54.7(4) ^{***}	239.0(7) ^{***}	12.7(5) [*]	1.5(1) ^{ns}	26.9(5) ^{***}	13.9(5) [*]

M = school mean; *denotes level 1 interaction effect to be tested in model 7; #denotes level 2 interaction effect to be tested in model 8; 20 countries, 534 schools, 11,582 students, average school size = 21.69 students; see Appendix for breakdown by country; M = school mean; df = degrees of freedom; *p < 0.05, **p < 0.01, ***p < 0.001, ns = not statistically significant

prevalence of 1G immigrants among school immigrant cohorts also had very similar effects across all three subject areas.

Pertaining to RQ2b, RQ3b, and RQ4b, in terms of within-school interactions, having a higher ESCS also seems to offer a particular advantage to 1G immigrants for both science and reading. Finally, parental emotional support appears to be particularly useful for 1G immigrants for math and reading outcomes.

4.7 Discussion, conclusion, and implications

The results of the present study show that the general academic performance of immigrant students is strongly associated with quite a consistent suite of factors embedded within immigrant students' immigrant status and attributes, and the immigrant experience in the broader school milieu. Using García Coll et al.'s (1996) theoretical framework, the study classified antecedents of immigrant students' achievement as social position variables (gender), "segregation" or "family" factors (ESCS), and inhibiting/promoting environments (student attributes and experiences, school provisions, and equity-oriented school policies). Their immigrant status (1G or 2G) was also used as a moderator to examine the differential factors within- and between-school levels. The results supported the integrative framework of García Coll et al. (1996) providing empirical evidence that the selected settlement, socio-demographic, and socio-psychological factors contribute to the achievement of the immigrant students.

4.8 Gender

Several studies have indicated that females are less successful than male students in math and science and that these gender differences may shrink over time (Bodovski et al., 2020). In the present study, at the within-school level, male immigrants were also found to be more successful in math and science, while females performed better in reading. Therefore, the findings in this study support results in previous studies that suggest that males tend to perform better in mathematics and science, and females tend to perform better in reading (Guiso et al., 2008; Ma, 2008; Marks, 2008; Martin, 2004, 2006; Stoet & Geary, 2013). Although the same pattern is observed in most participating countries in PISA, in math and science performance, girls scored higher than boys in some countries, and there are countries without a gender difference (OECD, 2019; Stoet & Geary, 2013). However, girls scored higher than boys in reading in all countries in PISA assessments (Khorramdel et al., 2020; OECD, 2019). However, this gender gap followed the same pattern in the immigrant populations (Arikan et al., 2017; Martin et al., 2012). Gender differences that favor males in science and math, and favor females in reading, may stem from gender-related cognitive differences (e.g., visual-spatial awareness in the required cognitive abilities Goldstein et al., 1990) or different achievement norms, for different subjects, created from cultures, ideologies, or traditions (Ma, 2008). However, the design of this study did not allow the identification of the reason for this gender gap.

4.9 Economic, social, and cultural status (ESCS)

In most countries, immigrant students are often from disadvantaged economic, social, and cultural backgrounds, which is one of the causes of their lower academic performance (Schleicher, 2006). This situation turns immigrant students' higher ESCS into a clear advantage, and, as the results of the current study revealed, coming from a higher ESCS background improves the academic performance of immigrant students for all three academic outcomes. This large effect is prevalent at both the within- and between-school levels, meaning that both the immigrants' socioeconomic levels and the proportion of the students from high ESCS level at a school have a positive influence on the academic performance of immigrants across all three subjects. This finding is supported by He and Fischer (2020), who found that a school's intake of students of low SES has a negative influence on the sense of belonging and academic achievement levels of the immigrant students. Furthermore, Bodovski et al. (2020) found that immigrant students lagged behind their native peers in both math and science, with 1G students performing worse, though all students with higher SES tended to perform better academically in both math and science. Therefore, overall, findings here suggesting that ESCS has a large within- and between-school effect on immigrant student academic outcomes provide nuance to the large body of research that also finds ESCS as the predominant contributor to academic performance (Aikens & Barbarin, 2008; Langenkamp & Carbonaro, 2018; Zhang & Liu, 2016).

The interaction effect exhibited between ESCS and immigration status at the within- and between-school levels provides additional insights into the influence of ESCS on the achievement of the 1G and 2G students. The impact of ESCS on achievement is substantially stronger for the 1G students for science and reading performance at the within-school level, meaning that individual ESCS background clearly provides more advantage to the 1G immigrants within schools. Also, the interaction effects at the between-school level revealed that the proportion of the students with higher ESCS background at a school provides more advantages to the 1G students in their reading performance. Similarly, Harju-Luukkainen et al. (2017) and Silveira et al. (2019) posited that higher ESCS contributes to the educational outcomes of 1G students more strongly than that of 2G students. Strain theory suggests that the 2G students are stuck in a social situation in which they adopt and internalize the host country's socio-cultural traditions and at the same time encounter discrimination and racism (Pérez et al., 2008; Silveira et al., 2019). Therefore, compared with 1G students, 2G students may not take specific advantage of various socioeconomic resources in order to benefit from them academically. This may explain the finding that ESCS may be of particular relevance to 1G students' science and reading outcomes. Given the particular advantage that ESCS affords to 1G immigrant students, governments may consider allocating additional funds, through per capita funding mechanisms, for example, to support the education of 1G immigrants in both the private and public school sectors. Research has suggested that simply increasing public spending on education helps immigrant students' achievement and educational equality (Marlow, 2000; Schlicht et al., 2010; West & Woessmann, 2008). Therefore,

specific financial provisions for 1G students may function to reduce immigrant achievement gaps.

Although the current results show that ESCS provides a clear advantage in academic achievement for all groups, especially for the 1G students, this might not be the case in some educational systems. The analysis of the TIES study revealed that the familial background had little impact on immigrant students' academic achievement in Sweden, which is a more open educational system than more stratified educational systems like Germany and Austria (Crul et al., 2012). Further research can clarify this issue in large scale assessments by taking into account the differences in the structures of educational systems.

4.10 Parents' emotional support perceived by a student

Research has suggested that immigrant students face emotional, psychological, and social hurdles, and their successes rely heavily upon extrinsic rewards, especially from their parents (Tebben, 2017). Parents' emotional support increases immigrant students' academic performance in all subjects, supporting the previous research findings that parents' emotional support plays a critical role in the academic engagement and achievement of the immigrant students (Garcia-Reid et al., 2015; Suárez-Orozco et al., 2009). Jung and Zhang (2016) stated that with parental support, immigrant children tend to have a positive relationship with academic achievement and performance in school. Within-school interaction effects suggested that the emotional support of students is especially crucial for the math and reading performance of 1G students, corroborating the previous research that parental support is especially helpful for newcomer (1G) immigrant students to bridge the higher gap between school and home cultures and to pave the way for a successful school life (Garcia-Reid et al., 2015; Rumberger, 2004; Suárez-Orozco et al., 2009). Moreover, Johnson et al. (2016) underlined that proactive parental support during school years including helping with homework and engaging with teachers not only was related to improved science, math, and reading achievement but also children's feelings of self-efficacy in school, children's self-regulation, and a decrease high school dropout rate. Therefore, in this context, school administrators may consider organizing seminars, workshops, and meetings for immigrant students' parents at a regular interval and instruct parents on how to communicate with teachers and staff members to support their children through parental involvement.

4.11 Adaptation of instruction and perceived teacher's interest [by a student]

Teachers' interest perceived by students, and teachers' adaptation of instruction to the needs, knowledge, and difficulties of students (perceived by students) enhance immigrant students' academic performance across all subjects. In PISA 2018, "teachers' interest" implies emotional and relational support (e.g., inspiring the students with enthusiasm and showing enjoyment in teaching) whereas "teachers' adaptation of instruction" refers to more tangible support (e.g., adapting the lessons to the special needs of students and providing individual help). Previous studies

also elucidated that both the emotional and tangible support that students receive from teachers keep immigrant students engaged, help them surmount the difficulties in their academic lives, and achieve a better performance level (Garcia-Reid et al., 2015; Ly et al., 2012; Suárez-Orozco et al., 2009).

4.12 Student's experience of being bullied

The experience of being bullied had a consistently negative effect on the academic performance of immigrant students across all three subjects at the within-school level. Besides, as a part of the school climate, if exposure to bullying is prevalent at a school, then immigrant students perform substantively worse across all three subjects at the between-school level. These results are consistent with previous research findings that indicate a negative effect of bullying experiences on immigrant students' academic performance (Lee et al. 2017, 2018; Suárez-Orozco et al., 2009). Being threatened and bullied by others in an unsafe school environment, immigrant students are more likely to develop lower academic expectations that decrease their immediate academic performance (Lee et al., 2018). This finding implies that immigrant students who perceive their schools as violent and threatening may be more susceptible to the development of academic complications (Suárez-Orozco et al., 2009). Bullying is a serious socio-developmental and academic performance issue and is associated with a range of short- and long-term problems among immigrant students who are bullied. Maynard et al. (2016) found that immigrant students who experience bullying victimization were more likely to report interpersonal, socio-emotional, low-academic performance, health, and substance use problems. Immigrant students who have been bullied are more likely to skip classes, drop out of school, and perform worse academically than schoolmates who have no conflictual relationships with their peers (Konishi et al., 2010; OECD 2017; Townsend et al., 2008).

According to Barrington (2018), students who are repeatedly bullied may experience physical symptoms like stomach pains, headaches, and trouble sleeping. These side effects may pair with anxiety about going to school or participating in class which only leads to further loss of interest and reduced academic performance. Also, a study showed that experiences with discrimination negatively impact the physical and mental health of immigrant students (Benner & Graham, 2011). Other studies emphasized that immigrant students who have been bullied by their peers are negatively affected with respect to acculturation or integration into a host society (Bjereld et al., 2015; Cacali, 2018; Yang, 2018) Therefore, it is essential to make efforts to improve cultural relevancy of antibullying programs to immigrant students. Given the greater risk and unique challenges experienced by immigrant students, prevention and intervention programs may need to be tailored to their specific needs and circumstances (Barrington, 2018; Maynard et al., 2016). Furthermore, social processes operating in schools that may explain bullying behaviors among immigrant and

non-immigrant youth should be explored to inform programs for promoting inclusion in schools (Plenty & Jonsson, 2017; Vitoroulis & Georgiades, 2017). Further research is needed to understand the specific factors and mechanisms involved in bullying victimization among immigrant students and the utility of antibullying programs on immigrant students' school experience in general.

4.13 School type

To note, immigrant students' performance studying at public schools was lower in model 3. However, after controlling for the effect of school mean ESCS in model 4, the impact of public school turns positive. This finding is supported by Zhang and Liu (2016) who found that the effect of public school in all PISA cycles (2000–2012) became positive when school mean ESCS was controlled for. However, the impact of school type became insignificant in subsequent models in the current study, suggesting that a school's average socioeconomic level is a more meaningful indicator of achievement, regardless of the school type.

4.14 Immigration status

Student status as 1G did not appear to have any substantive effect on math and science outcomes. However, 1G status did have a substantive negative effect on reading ability. This finding is somewhat consistent with the previous PISA findings suggesting that the reading skills and the language spoken at home are the critical factors inhibiting immigrant students' academic performance compared to students from non-migrant backgrounds (Entorf & Minoiu, 2005; Schleicher, 2006). It may be beneficial to have more substantial language support in schools with a heavier emphasis on language skills aiming at 1G immigrant students' integration to increase the academic performance of the 1G students.

At the between-school level, the proportion of 1G immigrants—compared to 2G immigrants—negatively impacts the performance of the students for all three subjects. This is consistent with the findings of Brunello and Rocco (2013), Gould et al. (2009), He and Fischer (2020), Jensen and Rasmussen (2011), and Schneeweis (2015) that a higher proportion of immigrant students has a detrimental effect on the academic performance of native and/or immigrant students at the school level. This may be due either to the adverse peer effects or reduced teacher attention because of the immigrant students' low proficiency in the local language of the country in which they study (Brunello & Rocco, 2013; Entorf & Lauk, 2008). Another consideration, as Schleicher (2006) proposed, relates to the fact that language support programs are less likely to be well established in the countries where the discrepancy between the achievement of 1G and 2G students is greater.

Corroborating these findings in previous studies, the results in the current study imply that the academic problems associated with the 1G immigrant

Table 6 Summary of results for immigrant student PISA math, science, and reading ability

Variable	Math Coefficient (<i>t</i>)	Science Coefficient (<i>t</i>)	Reading Coefficient (<i>t</i>)
Model 6 (level 1 direct effects: student attributes and experience)			
Gender (male focal group)	17.05*** (13.11)	7.65*** (5.65)	-14.62*** (-9.64)
PISA Index of economic, social, and cultural status (ESCS)	11.80*** (13.10)	11.36*** (12.12)	12.42*** (11.81)
Parents' emotional support perceived by student (WLE)	1.61* (2.35)	2.86*** (4.00)	3.58*** (4.46)
Perceived teacher's interest [by student] (WLE)	3.33*** (4.30)	3.61*** (4.47)	4.96*** (5.48)
Adaptation of instruction (WLE)	4.21*** (5.53)	3.56*** (4.49)	4.37*** (4.92)
Student's experience of being bullied (WLE)	-5.94*** (-8.92)	-6.51*** (-9.39)	-7.80*** (-10.04)
Immigration status (IG focal group)			-4.47*** (-2.70)
Model 6 (level 2 direct effects: school provisions)			
Creative extracurricular activities	7.47*** (3.70)	7.90*** (4.03)	10.25*** (4.89)
Shortage of educational staff	-5.01* (-2.26)	-5.42* (-2.51)	-5.93*** (-2.57)
Model 6 (level 2 direct effects: aggregated student attributes and experience)			
Gender (male focal group) (<i>M</i>)			-30.50* (-2.21)
PISA Index of economic, social, and cultural status (ESCS) (<i>M</i>)	57.36*** (14.76)	57.06*** (15.04)	61.79*** (15.22)
Student's experience of being bullied (<i>M</i>)	-27.51*** (-4.31)	-25.76*** (-4.14)	-29.92*** (-4.34)
Immigration status (IG focal group) (<i>M</i>)	-38.55*** (-4.19)	-28.75*** (-3.21)	-34.81*** (-3.63)
Model 6 (level 2 direct effects: school specialized immigrant student policy)			
Before transferring to regular classes, students receive targeted preparatory program		10.42* (2.48)	
Model 7 Coefficients (Level 1 interaction effects)			
ESCS × Immigration status		3.73** (2.60)	6.04*** (3.76)
Parents' emotional support perceived by student × Immigration status	3.92** (2.90)		3.67* (2.33)
Perceived teacher's interest × Immigration status	-3.04* (-2.01)	-3.34* (-2.12)	
Model 8 Coefficients (Level 2 interaction effects)			
ESCS (<i>M</i>) × Immigration status			33.16** (2.69)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

students can potentially impact other students studying in the same school. The findings in this current study add to previous research that relates to the proportion of immigrants in school and overall poorer outcomes. The results here identify that a higher proportion of 1G students—compared to 2G students—is also associated with poorer outcomes. We suspect that this might also be described by teaching resources being absorbed by immigrants (Brunello & Rocco, 2013). However, there are opposing findings in the literature suggesting that a higher share of immigrants may contribute to the educational outcomes of immigrant and/or non-immigrant students in various contexts due to the benefits of studying in multicultural settings (Brandén et al., 2019; Fekjær & Birkelund, 2007; Hermansen & Birkelund, 2015; Silveira et al., 2019). The current findings provide a general insight into this issue, but other researchers could consider more specific combinations of various levels of segregation (e.g., 10% vs. 25% or 20% vs. 70% etc.) and their potential impacts on performance to clarify the possible associations between different shares of immigrants at school and educational outcomes. It would be helpful to conduct further research on this controversial issue to determine why immigrants and/or native-born students perform academically better or worse in particular educational contexts.

4.15 School specialized immigrant student policy—between-school level

The findings on school specialized immigrant student policies revealed that immigrant students perform better in science at schools in which immigrant students receive targeted preparatory programs before transferring to regular classes. Among the five items of the school's equity-oriented policies, this item was the only significant policy, and it had a marginally significant effect (was not considered substantive) only on the science achievement of immigrant students. Besides, previous studies have reported controversial information about the benefits of these types of targeted preparatory programs before attending regular classes for immigrant students. Some studies have elucidated that these types of preparatory programs can facilitate the academic and psychosocial adjustment of immigrant students in school (Makarova & Birman, 2016; Vedder et al., 2006; Warikoo & Carter, 2009), while others have argued that those programs might function as a segregating factor and negatively impact their social integration and psychological well-being (Allen, 2006).

Although it is helpful to determine systemic equalitarian policies and practices at the school level, practitioners should take various individual- and group-level differences into account when applying these policies. Our findings suggest, in general, that immigrant students' individual and familial characteristics, their attributes and experiences, and school provisions are more important indicators of their academic performance over and above the implementation of targeted school policies.

We only found one marginally significant item out of the five equity-oriented policies in the PISA 2018 cycle. PISA survey provides limited insight

into schools' immigrant student policies. Those policies included in the survey could have different backgrounds, such as reducing the distraction of classroom teachers by newcomer students, and this would not be motivated by a worry about equity for students with migration backgrounds. Besides, school structures and teaching philosophies, which are often connected with each other, vary considerably across the participating countries. Therefore, the real impact of those policies can only be fully understood in combination with the other driving forces of learning in the classroom as well as the general public discourse on the implementation of those measures.

4.16 School provisions—between-school level

The findings of the school provisional variables reveal that the number of “creative extracurricular activities” contributes to the academic performance, and the “shortage of educational staff” contributes negatively to the achievement of immigrant students across all three subjects. Corroborating the previous research findings (Blomfield & Barber, 2011; Camacho & Fuligni, 2015; Im et al., 2016), the current results revealed that the provision of extracurricular activities with enough “soft” educational resources has the potential to narrow the gap between the learning outcomes of immigrant and non-immigrant students.

On the other hand, research by He and Fischer (2020) suggested that grading based on the provision of extracurricular activities had mixed associations with the positive academic outcomes across countries and did not fulfill the potential to enhance immigrant students' outcomes. Nevertheless, the emphasis of extracurricular activities on facilitating high-quality social interactions was found to be beneficial for non-academic outcomes, such as a sense of belonging, and to reduce problem behaviors and the likelihood of dropping out (Brown & Evans, 2002; Fredricks & Eccles, 2006; Mahoney et al., 2003; McNeal, 1998), and the positive effects of extracurricular activities have been found for youth from diverse backgrounds (Jiang & Peguero, 2017). Thus, schools would be well placed to tailor and encourage immigrant student involvement in extracurricular activities with a view toward enhancing integration and involvement in general.

4.17 GDP per capita

Although substantial differences are present in the achievement scores of immigrant students at the between-countries level, the GDP per capita of the countries did not explain these differences. There are possibly other variables regarding the country-specific policies or provisions that may alleviate segregation, provide upward mobility, and predict immigrant students' achievement (Hochschild & Cropper, 2010). The present study did not include other variables at the country level. Still, other researchers can test the impact of other

plausible factors to explain the achievement gaps between the 1G and 2G immigrant populations studying in different countries.

In sum, immigrant students often perform lower than their native counterparts; however, they have specific learning dispositions and attitudes toward school that can be enhanced by the schools to assist them in succeeding in the education system (Alivernini et al., 2018; Schleicher, 2006). Similar to the findings of Martin et al. (2012), the results of the current study imply that it is not immigrant status per se that explains lower academic performance; rather, various student attributes, school experiences, and socio-demographic factors associated with their immigration status that are key determinants in explaining the substantial differences in achievement. There are scores of factors and adverse circumstances in the lives of immigrant students that may lead practitioners and researchers to resort to explaining those differences with possible deficit interpretations (Valencia, 2012).

However, the results of the current study support the multidimensional and integrative theoretical frameworks, including various moderators and covariates (García Coll et al. 1996), while explaining the reasons for the poor academic performance, rather than viewing those factors from a deficit framework. The results of this study reveal the focal role that schools have in supporting the academic development and integration of immigrant students by creating a safe and supportive climate, extracurricular options, an enthusiastic teaching cohort, an adapted instruction, and parent–school support structures.

5 Limitations of the study

The present study was only able to test student-, school-, and country-level predictors of achievement, using the PISA data set. However, many possible variables exist at the classroom level that the PISA data cannot assess, and school-level aggregations of student and teacher views may not always provide reliable information (He & Fischer, 2020). Other researchers can collect data from student, classroom, school, and country levels at the same time to identify the distinctive intervention points across all levels.

Only GDP per-capita scores were taken at the country-level analysis in this study. However, country-level variations in educational opportunities cannot only be attributed to economic differences. The analyses of the TIES (The Integration of the European Second Generation) study suggest that structural aspects of institutional arrangements in European countries, such as the integrative nature of education systems, welfare arrangements, and legal frameworks, impact migrant students' success (Crul et al., 2012). Future studies could include variables regarding the structure of educational systems to account for country-level differences in migrant students' integration and success.

Our comparisons between 1 and 2G immigrants should be taken with caution when comparing specific countries. Although we have general assumptions about the status of 1G and 2G immigrants, it is mainly a theoretical

classification in social sciences, and the analytical categories within different countries might vary and have little in common as the source country composition can be very different for early waves of immigrants (i.e., 2G students' parents might be recruited workers) and recent immigrants (i.e., 1G students' parents could be mainly refugees from war-torn countries with little schooling themselves). It should also be noted that the PISA survey does not identify the number of years that the 1G immigrant has been in the country. This would likely also be an essential factor associated with language acquisition. Researchers are advised to consider other possible within-country combinations of various immigrant groups and refrain from overgeneralizing their results while comparing 1G and 2G immigrant students.

The variables regarding school provisions in the PISA survey are far from enabling us to sufficiently compare school systems which are very differently structured according to their start dates, compulsory education, selection and transition focus, sequential steps of education levels, repetition rates, special education schools, and differentiation between vocational and academic tracks, which all impact the integration and educational outcomes of migrant students (Crul et al., 2012). Researchers are advised to consider distinctive structural features of different educational systems when comparing the cases of migrant students in their contextualities.

The study at hand identified consistent within- and between-school effects across subjects. Also, the exceptionally high between-school correlations across all three subjects buttress the ability to generalize these consistent findings at the between-school level—the drivers of improved academic outcomes appear to be very much cross-disciplinary. Despite this, the current PISA data used in this study were not entirely sufficient to capture a nuanced understanding of the experiences of immigrant students. Therefore, jurisdictions should undertake their own country-specific research. Our view is that it would be better for policymakers to situate their own country's or school's contextual characteristics while making efforts to ameliorate the educational outcomes of immigrant students.

The current PISA data set collected from multiple countries subsumes extremely different immigrant populations, making it difficult to reach more concrete results. The respondents from the same source country as the analytical categories of 1G and 2G immigrant students can be coded and classified to uncover the variations across different school systems, as Crul et al. (2012) did. Their analytical strategy could be used as a blueprint for more studies to compare the antecedents of educational attainments of multiple groups of migrants across various countries included in large-scale assessments.

The PISA data is also unable to account for the return or circular migration patterns (forward or backward migration of families) that would reflect upon the achievement of specific immigrant populations (Volante et al., 2019). Thus, a need exists to collect comprehensive data to understand the effect of migration patterns on the achievement of immigrant student groups using both qualitative and quantitative methods.

Appendix

Table 7 List of countries and sample sizes in study

Country	Code	Sample Size (<i>n</i>)	Number of Schools (<i>s</i>)
Australia	36	659	52
Austria	40	260	18
Brunei Darussalam	96	283	8
Costa Rica	188	90	7
Denmark	208	166	12
Estonia	233	103	9
France	250	99	8
Hong Kong	344	1139	63
Kazakhstan	398	271	16
Jordan	400	21	2
Lebanon	442	1720	30
Macao	446	1666	32
Malta	470	65	4
Montenegro	499	211	13
New Zealand	554	485	27
Singapore	702	523	35
Switzerland	756	394	32
United Arab Emirates	784	2758	120
United Kingdom	826	245	18
United States	840	424	28
Total		11,582	434

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Data availability PISA 2018 data files used in this study are available at the OECD's website.

Code availability (software application or custom code) The open-source software R was used in this study with the lme4 (linear mixed-effects) package's lmer function. Derived data supporting the findings of this study and the R codes are available from the corresponding author on request.

Declarations

Conflict of interest The authors declare no competing interests.

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