A Countability Quandary:

Investigating the Higher Achievement of French-Language Schools on EQAO Math Assessments

Theo J. O'Connell

2023/24 Laidlaw Scholar

theo.oconnell@mail.utoronto.ca

Dr. Meï-Lan Mamode

Research Advisor

meilan.mamode@utoronto.ca

Abstract

Though significant differences have previously been observed between Ontario's English- and French-language school systems, direct comparisons between systems on provincial assessments were not feasible due to differences in curricula. The standardization of Ontario math curricula in 2020 (Grades 1–8) and 2021 (Grade 9) between language systems presents the first opportunity in EQAO's existence to draw such comparisons. Thus, this study comparatively analyzes achievement on province-wide EQAO math assessments by language systems. A linear mixed-effects model was employed to address two research questions: first, to assess whether a significant achievement gap existed on EQAO math assessments during the 2022–23 period (RQ1), and second, to determine the effects of ten potential predictors of achievement, identified from the literature (RQ2). These predictors are: (1) language of instruction, (2) enrolment, (3) per-student funding, (4) remoteness, (5) dispersion, (6) urban factor, (7) percentage of female students, (8) percentage of students eligible for ELL or ALF supports, (9) percentage of students identified with special needs, and (10) percentage of students born outside Canada. The results show that students in French-language schools were significantly more likely to achieve a passing grade (Level 3 or 4) compared to their peers in English-language schools. However, this effect was moderated by the proportion of students eligible for ELL or ALF supports, indicating that the interaction between language system and student demographics has a combined influence on achievement. We conclude that the observed advantage of French-language schools on EQAO math assessments is influenced by the demographic characteristics of their student populations.

Keywords: EQAO, mathematics, large-scale assessment, student achievement, linear mixed modelling

Résumé

Il a précédemment été observé que le taux de réussite aux examens de l'Office de la Qualité et de la Responsabilité en Éducation (OQRE) pouvait différer en fonction du système scolaire ontarien (anglais versus français) dans lequel l'examen était administré. Jusqu'ici, une comparaison directe de ces taux de réussite n'a jamais été possible ni recommandée en raison de différences curriculaires entre ces deux systèmes. Cependant, grâce à la récente standardisation du curriculum de mathématiques des deux systèmes scolaires en 2020 (Grades 1 à 8) et en 2021 (Grade 9), cette comparaison est maintenant possible pour la première fois depuis l'existence de l'OQRE. Ainsi, cette étude étudie les différences de taux de réussite entre les systèmes scolaires français et anglais de l'Ontario aux examens de mathématiques de l'OQRE. Pour ce faire, un modèle à effets mixtes a été employé pour répondre à deux questions de recherche : (1) En 2022–2023, y a-t-il eu une différence significative du taux de réussite entre les deux systèmes scolaires ? ; (2) Quels sont les facteurs qui ont potentiellement pu contribuer à cette différence? À partir des recherches antérieures, nous avons isolé neuf facteurs potentiels : (1) le taux d'inscription, (2) le financement par étudiant, (3) le degré d'isolement, (4) la dispersion, (5) le facteur urbain, (6) le pourcentage d'étudiants de sexe féminin, (7) le pourcentage d'étudiant.e.s admissibles aux supports d'ELL et d'ALF, (8) le pourcentage d'étudiant.e.s ayant des besoins particuliers, (9) le pourcentage d'étudiant.e.s né.e.s à l'extérieur du Canada. Les résultats ont démontré que les étudiant.e.s du système français ontarien ont obtenu un taux de réussite significativement supérieur à celui du système anglais ontarien. Cependant, nous avons trouvé que cet effet était modéré le pourcentage d'étudiant.e.s admissibles aux supports d'ELL et d'ALF. De plus, hormis le système d'instruction, trois autres facteurs ont significativement influencé le taux de réussite global, indépendamment du système scolaire: le financement par étudiant, le pourcentage d'étudiant.e.s ayant des besoins particuliers, et le pourcentage d'étudiant.e.s né.e.s à l'extérieur du Canada. Nous concluons donc que l'avantage perçu des écoles du système français est fortement influencé par les caractéristiques démographiques de sa population estudiantine.

Keywords: OQRE, mathématiques, évaluation à grande échelle, réussite des élèves, modèle à effets mixtes

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I. Introduction

Monitoring student achievement allows administrative actors to better understand the potential needs and challenges of various student populations. In Ontario, the Education Quality and Accountability Office (EQAO), a provincial government agency, serves this purpose. Since its conception in 1996, EQAO has been responsible for the annual creation, distribution, and grading of four major standardized tests administered to all Public and Catholic schools across the province: two Assessments of Reading, Writing and Mathematics for students in Grades 3 and 6 (known as the Primary- and Junior-Division assessments, respectively), the Grade 9 Assessment of Mathematics, and the Ontario Secondary School Literacy Test (OSSLT) in Grade 10 (EQAO, n.d.).

The *Canadian Charter of Rights and Freedoms* mandates the right of English- or French-speaking parents in a minority language population to enrol their children in primary and secondary education corresponding to that language (*Canadian Charter of Rights and Freedoms*, s 23). As such, though all regions of Ontario are not officially bilingual, K–12 education in the province comprises both English- and French-language systems. Accordingly, EQAO assessments are designed and administered in both languages, though there remain numerous obstacles to the comparison of student achievement thereon between language systems. These confounding factors, identified later with insights from relevant literature (e.g., Chang, 2011; Prasad, 2009; Dénommé, 2006; and Dénommé & Childs, 2008), limited the reliability of such comparisons across all provincial assessments for over two decades. However, with the standardization of the Ontario math curriculum for Grades 1–8 across language systems in 2020 (Ministry of Education, 2024a), and for Grade 9 in 2021 (Ministry of Education, n.d.), researchers are now better equipped to compare English- and French-language achievement results on EQAO math assessments. The present study therefore compares student achievement between language systems on the mathematics component of both Primary- and Junior-Division assessments as well as the Grade 9 Assessment of Mathematics, focusing only on EQAO assessments administered at the provincial level.

In this paper, the qualifiers ‘English-language’ or ‘French-language’ in reference to district school boards indicate the language in which students enrolled in these boards are instructed. Please also note that EQAO achievement results for students in the French Immersion program, a French as a Second Language program offered solely by English-language schools, are counted for the English-language system.

Language systems in Ontario

Ontario’s two language systems comprise four publicly funded school systems: English Public, English Catholic, French Public, and French Catholic (Ministry of Education, 2024b). A child is eligible for primary and secondary education in the province’s French-language system if

the child is considered a French-language rights holder[1] per Section 23 of the *Charter* (*Canadian Charter of Rights and Freedoms*, s 23). In 2021, 12.6% of Ontario youth under 18 had such eligibility, for an approximate total of 350,000 youth (Statistics Canada, 2022). Ontario's English-language system, which in 2023 had approximately 17 times as many students enrolled as the French-language system, reflects the province's larger proportion of Anglophone youth (Ontario Data Catalogue, 2024) Since their establishment in 1998, French-language school boards in Ontario have faced many, often unique challenges, largely stemming from French being a minority language within the province. For instance, Allen & Cartwright (2004) reported that French-language schools had few resources and high exposure to the English language, hence limited immersion in the French language and Franco-Ontarian culture (Allen & Cartwright, 2004). Allen & Cartwright's findings echoed prominent concerns within Ontario's Francophone community at the time, which in 2004 prompted the Ministry of Education to create a policy aiming to improve the quality of instruction in French-language schools, further the cultural and linguistic enrichment believed essential to the development of early literacy skills, and increase enrolment in the French-language system, among other goals (Dénommé, 2006).

Determinants of achievement

As the present study finds, EQAO achievement of students enrolled in the French-language system is now higher on average than that of English-language students in the subject of focus, math. Though this development is certainly the result of many combined factors, one possible explanation is that French-language district school boards tend to receive higher per-student funding from the Ministry of Education than their English-language counterparts. A report published by the Financial Accountability Office of Ontario (FAO) reveals that in the 2021–22 school year, French Public and Catholic systems received an average per-student funding of $18,133 compared to $13,140 for English Public and Catholic systems (Gordon et al., 2023). The majority of this was from Grants for Students Needs, which have since been restructured into Core Education Funding (or 'Core Ed') effective the 2024–25 school year. In prioritizing school boards with lower enrolment as well as greater remoteness and dispersion of schools, these grants naturally tended to favour French-language school boards in 2022 (ibid). However, given the recency of the Core Ed funding model, which reduces the 18 grants to six funds and the 77 allocations to 28 (Ministry of Education, 2024c), any potential changes in this trend remain unclear.

In addition to enrolment and per-student funding, current literature identifies a number of other factors with a potential effect on students' EQAO achievement. Three such variables were reported in a 2022 data set created by FAO: these are (1) remoteness, the distance (in kilometres) of a given school board's central office to an urban centre of at least 200,000 people; (2)

[1] Ontario's eligibility criteria for becoming a French-language rights holder can be found in Section 23 of *The Canadian Charter of Rights and Freedoms*, or abridged in the following publication by Statistics Canada: https://www150.statcan.gc.ca/n1/daily-quotidien/221130/dq221130d-eng.htm.

dispersion, the weighted average distance among a board's schools and of its central office to each school; and (3) urban factor, weighted by enrolment and measured from 0 (most urban) to 1 (most rural). Given the tendency of Core Education Funding to allocate more funds to boards with low enrolment as well as high remoteness, dispersion, and urban factor, the three FAO-identified variables along with enrolment are likely correlated with per-student funding. There has also been evidence to suggest the existence of a rural–urban achievement gap in Canadian education, such as the lagging performance of students from more rural communities on the math, reading, and science dimensions of PISA, an international assessment (Canadian Council on Learning, 2006).

Several characteristics of student populations were also taken into consideration. First, a student's gender is considered by some researchers to be a salient predictor of achievement (Vincett, 2016; Chen, 2016; Landry et al., 2015; Hall, 2012). Noting that female students typically outperform male students on Ontario secondary school reading assessments, Vincett considers cumulative factors relating to how students of different genders are socialized as a possible explanation (Vincett, 2016). This idea is supported by Pyle and Prioletta, who examined footage of children playing to assess how literacy-based play is integrated into Ontario kindergarten classrooms and how participation therein differs by gender. Here, the researchers found that boys and girls often play separately, and that girls were twice as likely as boys to engage in literacy-based play (Prioletta and Pyle, 2017).

Whether a student is identified as having special education needs by an Identification, Placement and Review Committee (IPRC) also correlates with achievement. Schulte & Stevens (2015) found that students with special education needs tend to achieve lower on standardized math assessments (Schulte & Stevens, 2015). Furthermore, while Individual Education Plans (IEPs) help identify students with exceptionalities and outline necessary learning supports, a student is only provided one if recognized by an IPRC to have special education needs (Vincett, 2016). Vincett (2016), in exploring achievement across EQAO assessments administered to Grades 3, 6, and 10, found that students with IEPs predominantly followed a trajectory of failing these grades' three EQAO assessments, with the next most common pattern being failing the Grade 3 and 6 tests but passing the OSSLT. This not only highlights the academic challenges that students with exceptionalities face, but also demonstrates that obtaining necessary supports may take time (ibid).

Another significant characteristic is a student's status as an English Language Learner (ELL), a student in the English-language system learning both the language of instruction and the curriculum material who is entitled to special supports. ELL students are recognized under both the English as a Second Language (ESL) and English Literacy Development (ELD) programs (Ministry of Education, 2024d). In the French-language system, the closest equivalent to an ELL student is a beneficiary of the *Actualisation Linguistique en Français* (ALF) program, which instead focuses on improving students' French (particularly among Anglophones, as mentioned in a 2010 report) (Ministry of Education, 2010). Adesope et al. (2010) note that while ELL students may face challenges concerning literacy, their performance in math can match or

exceed that of non-ELL peers (Adesope et al., 2010). Conversely, such students in Ontario have also been shown to achieve lower on international assessments and the OSSLT (Vincett, 2016).

Finally, whether a student is born in Canada or abroad appears to be a reasonable predictor of EQAO achievement. Fuligni (1997) notes that immigrant families in Canada often place a higher value on education, with strong parental expectations contributing to academic performance comparable to that of native-born students (Fuligni, 1997). Additionally, factors such as peer influence and familiarity with test formats play a significant role in academic outcomes. While immigrant children who initially speak neither of Canada's official languages may underperform, they often catch up by the end of primary school (Fox & Cheng, 2007). Current literature also highlights more complex yet important factors such as race (Vincett, 2016; Eizadirad, 2019) and socio-economic status (Langois, 2017) as predictors of student achievement on EQAO assessments, though these data are not collected by EQAO and would be especially challenging to measure with quantitative methods. Many of the variables identified in this section, and particularly the effect of each on student EQAO achievement, will be discussed in later sections.

Comparison: obstacles and opportunities

Nonparallel curricula between language systems pose a significant obstacle to the reliable comparison of English–French EQAO achievement. Prior to this study's publication, EQAO addressed this challenge in a brief statement on its website:

> Ontario curricula for French- and English-speaking students are specific to the two student populations. The specific expectations are similar but organized differently in each curriculum. Since EQAO's large-scale assessments are based on the respective curricula, the results of the two student populations should not be compared. (EQAO, 2022).

As confirmed by a representative of EQAO, the above statement applies only to extant curricula for non-math subjects, which are not directly translated but rather created by separate teams based on guidelines provided by Ontario's Ministry of Education, and has since been removed. Psychometric differences between English- and French-language assessments similarly limit opportunities for direct comparison. On non-math assessments, standards are set differently in each language system; thus, a student who is considered to meet expectations in one system might not in the other. The earlier EQAO representative noted that while the English–French achievement gap used to be larger, it has noticeably narrowed since math assessments were standardized, potentially indicating that standards were previously set lower for students enrolled in the French-language system.

Linguistic differences between assessments are another vital consideration. Chang (2011) highlights that native speakers of a Romance language such as French may pay more attention to the ends of words than native English-speakers (Chang, 2011). The limited immersion of many Franco-Ontarian students in the French language may also complicate matters, as can the

increasing enrolment of culturally and linguistically diverse students, or "students who might otherwise be labeled as second or additional language learners [...] who do not come to school already proficient in the language of the instruction", in the French-language system (Prasad, 2009). In 2021, 44% of Ontario children eligible for French-language education had an immigrant background (Statistics Canada, 2022).

Since comparing EQAO achievement between language systems has historically been infeasible, the one national and three international assessments in which Ontario participates[2], uniquely designed with comparison in mind, previously presented the most reliable opportunities to compare the achievement of the province's English- and French-language systems on standardized tests (Dénommé, 2006). These assessments, like those administered on the provincial level, were nonetheless vulnerable to a range of confounding factors, from differences in curricula and teaching practices to cultural and behavioural differences in student populations (Dénommé & Childs, 2008). While many such confounding variables still exist on the provincial level, the standardization of the Ontario math curriculum for Grades 1–9 provides an appropriate rationale for the comparisons drawn in this study.

Math curricula and assessments

The standardization of math curricula across Ontario's language systems in recent years marked the first updates to either curriculum since 2005. These changes highlight the province's ongoing efforts to streamline how math is taught by focusing on "real-life job skills", ensuring that students understand foundational concepts in the process (Ministry of Education, 2024e). The most notable result of this commitment to date is Ontario's Four-Year Math Strategy, created in 2019 and involving a cumulative investment of $200 million over four years into improved training for teachers, online tutoring programs, and summer learning programs, to name a few key initiatives (Ontario Newsroom, 2019). The *Better Schools and Student Outcomes Act*, which priotizes a renewed focus on "hands-on learning and skills development in reading, writing and math" for Ontario K–12 students, was passed to a similar end in June 2023 (Legislative Assembly of Ontario, 2023). Examining the average EQAO pass rate of each Ontario school board across reading, writing, and math assessments lends context to the Province's urgency. Indeed, of Ontario's 72 public school boards, we found there were only 11 for which the math pass rate was not lower than those of both reading and writing in the 2022–23 school year; 6 such schools are French Catholic, 4 French Public, and 1 English Public. In all these cases with the exception of one tie, the writing pass rate was second. These findings draw from publicly available student achievement data available on EQAO's website.

Implemented the 2020–21 school year, the revised Grade 1–8 math curriculum was another facet of the Four-Year Math Strategy. This new curriculum attempts to clarify the connection between math concepts learned in consecutive years, use assignments as an

[2] National: the School Achievement Indicators Program (SAIP). International: the Trends in International Mathematics and Science Study (TIMSS), the Progress in International Reading Literacy Study (PIRLS), and the Programme for International Student Assessment (PISA).

opportunity to build helpful life skills, have students memorize "number facts" (e.g., calculations up to 12 × 12 on the multiplication table), and more (EQAO, 2024a). It also places greater focus on the topics of spatial reasoning, coding, and financial literacy (ibid); EQAO math assessments were redesigned according to these changes. The table below outlines the skills assessed in all three updated EQAO math assessments, the number of questions for each, and the percentage of the assessment each skill comprises.

Table 1

Skills assessed in each EQAO math assessment/assessment component (EQAO, 2024b; EQAO, 2024c; EQAO, 2024d)

Assessment	**Skills assessed**	**# of questions**	**% of assessment**
Mathematics component of Primary-Division (Grade 3) assessment	Number & Financial Literacy	14	35%
	Algebra	8	20%
	Data	8	20%
	Spatial Sense	10	25%
Mathematics component of Junior-Division (Grade 6) assessment	Number	14	32%
	Algebra	9	20%
	Data	8	18%
	Spatial Sense	9	20%
	Financial Literacy	4	9%
Grade 9 Assessment of Mathematics	Number	10	20%
	Algebra	18	36%
	Data	8	16%
	Geometry and Measurement	8	16%
	Financial Literacy	6	12%

Due to the COVID-19 pandemic, all EQAO assessments have been completed online since the 2021–22 school year.[3] The three math assessments therefore consist of various forms of selected-response questions. Moreover, all three use a multi-stage computer adaptive testing model, wherein each stage of the assessment (with an estimated duration of approximately 30 minutes each) "is made up of modules that contain questions of a specific overall level of difficulty (medium, low/medium, or medium/high)" (EQAO, 2024b; EQAO, 2024c). Within this model, a student's performance in one module directly affects the difficulty of the next one the student is asked to complete. Though this may hinder the validity of EQAO results given the model's limited standardization, discussions of it are curiously absent from current literature, perhaps due to its recency.

Research questions

Building upon observed trends in student achievement and the recent standardization of Ontario's math curricula, this study is guided by the following two research questions (RQs):

1. Was there a significant achievement gap between English- and French-language schools on EQAO math assessments for the 2022–23 assessment period?
2. If so, which factors may have contributed to this disparity?

II. Methods

Data sources

In answering the second research question, we selected the following variables based on the findings of the earlier literature review: (1) enrolment, (2) per-student funding, (3) remoteness, (4) dispersion, (5) urban factor, (6) the percentage of participating students who were female, (7) who were eligible to receive either ELL or ALF supports, (8) who were identified as having special education needs, and (9) who were born outside Canada. Variables 1–5 were obtained from FAO's aforementioned 2022 data set, which itself draws from school board financial statements and data provided by the Province (Gordon et al., 2023). Data from this set were reported exclusively on the school board level. All other variables were obtained from EQAO through a data request, and reflect figures for the 2022–23 school year. Other key variables included from EQAO's 2023 data set are language of instruction, grade, school board name, and school name. Unlike for the FAO data set, data obtained from EQAO were reported on the school level. Thus, to facilitate the later data analysis, the two data sets were combined and data collected by FAO were applied to all schools within a given board.

[3] As mentioned by the earlier EQAO representative, however, students with certain accommodations (e.g., the need to have assessments delivered in braille, sign language, or through audio) may take EQAO tests in the paper-and-pencil format as needed. Furthermore, in the language component of Primary- and Junior-Division assessments, students may use a printed response sheet for open-response questions.

This study avoids the analysis of longitudinal data for two main reasons. First, data from 2003 (the earliest year for which data is available) until 2019 are split between Academic and Applied streams, discontinued in 2022 (DeClerq, 2021). Before their discontinuation, however, there was a marked achievement gap between these streams, with students enrolled in the Academic stream tending to achieve higher on EQAO assessments (Vincett, 2016). Second, because the 2021–22 school year saw EQAO assessments across both language systems move from the standard paper-and-pencil format to an online format, comparing pre- and post-pandemic achievement is infeasible. As more data become available with each new assessment period, the comparative analysis of English- and French-language systems with data spanning multiple years will become an increasingly viable research model.

Sample characteristics[4]

Both data sets used in this study encompass Ontario's 72 public district school boards. Although these two data sets differ in their levels of specificity, the board-level data were nonetheless obtained and averaged from individual schools. In EQAO's data set, which includes school-level data on student achievement, the sample encompasses 7858 Ontario schools. Of these, 7143 (90.9%) belong to the English-language system and the remaining 715 (9.10%) to the French-language system, which together comprised 436,145 EQAO-registered students. The sample sizes of each grade were similar, with Grade 9 having the most registered students (156,060), followed by Grade 6 (141,458) and finally Grade 3 (138,627). In the 2023 EQAO assessment period, a total of 392,939 (90.1%) English-language students and 23,863 (5.47%) French-language students fully participated in an EQAO math assessment. Of the 279,507 Grade 3 and 6 students registered to write a math assessment component, 7391 English-language students and 390 French-language students were formally exempted from participation in it. EQAO allows a student such an exemption "if the student requires mathematics terms to be defined." (EQAO, 2024e). These data were not available for the Grade 9 Assessment of Mathematics, for which there are no clear exemption criteria. In addition to exempted students, across Grades 3 and 6 there were a total of 1,608 students absent from a math assessment in the English-language system and 119 in the French-language system. Instances of a student yielding no usable data, whether "due to absence or other reasons" (EQAO, 2022), across all three grades numbered 27,515 and 1,780 in English- and French-language systems, respectively. Finally, both language systems had an approximately equal ratio of fully participating male to female students.

Measuring achievement

This study operationalizes student achievement on EQAO assessments according to benchmarks used by EQAO. The grading scheme for all such assessments comprises four levels

[4] For all percent figures in this section, the denominator is the total number of EQAO-registered students (including those who did not participate) across Grades 3, 6, and 9.

of achievement corresponding to different ranges on a traditional percentage grading scheme. Levels 1–4 are defined in the table below.

Table 2

Outline of the four-level grading scheme used for EQAO assessments (ibid)

Level	**Percent grade range**	**Description**
Level 4	80–100%	Surpasses the provincial standard
Level 3	70–79%	Meets the provincial standard
Level 2	60–69%	Approaches the provincial standard
Level 1	50–59%	Much below the provincial standard

These four levels of academic achievement exist relative to the province's expectations for how well students should understand the content taught in their respective grades. A student who achieves a Level 3 or 4 on an EQAO assessment, for instance, is considered to have met or exceeded provincial learning expectations, respectively. To use EQAO's phrasing, "[p]arents/guardians of students achieving Level 3 can be confident that their children will be prepared for work in the next grade." (EQAO, 2024b; EQAO, 2024c; EQAO, 2024d). This study therefore uses the combined percentage of students with overall achievement at or above the provincial standard—that is, having achieved a Level 3 or 4—as the metric of academic achievement and dependent variable. These data are available separately for the Grade 3, 6, and 9 EQAO math assessments.

Data processing

Before analyzing our data, we performed several transformations to account for scale differences, including min-max normalization of per-student funding (range: 11,729–35,192) and dispersion (3.8–189.0) as well as recoding of remoteness (151–1,709)[5] and enrolment (610–230,847). Urban factor had already been normalized and recoded by FAO. Data for both RQs were evaluated by means of a linear mixed-effects model (LMM), which provided the opportunity to model both fixed effects (the consistent, predictable impact of independent variables on the dependent variable across all groups) and random effects (the variability in the dependent variable, attributable to grouping factors). This method of data analysis also accounted

[5] The lowest remoteness values, which in the FAO's data set were all categorized as <151, were approximated in this study as exactly 151 for ease of analysis.

for the hierarchical structure of the data, with grades nested within schools and schools within school boards.

Data analysis: RQ1

Using R with the lme4 package, we ran a first LMM to examine the relationship between the primary independent variable (IV), language of instruction, and the dependent variable (DV), the percentage of students having achieved a Level 3 or 4. Several other IVs believed to have an effect on Level 3/4 achievement were included in the model; the following list restates these variables with their short names in parentheses: enrolment (*totalenrolment_x*), per-student funding (*perstudentfunding_normalized*), remoteness (*remoteness*), dispersion (*dispersion*), urban factor (*urbanfactor*), the percentage of participating students who were female (*pctFemale*), who had ELL or ALF eligibility (*pctELL_ALF*), who were identified as having special education needs (*pctSpecialNeeds*), and who were born outside Canada (*pctBornAbroad*). These additional variables, all kept constant, were included to isolate the unique contribution of language, controlling for potential confounding factors that might otherwise bias the results.

Model fit was assessed by comparing four models (Model 1–Model 4) using the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and log-likelihood values. Each model varied in terms of fixed effects and random effects. Fixed effects included enrolment, per-student funding, remoteness, dispersion, urban factor, the percentage of participating students who were female, who were eligible for ELL or ALF supports, (8) who were identified as having special education needs, and (9) who were born outside Canada. Random effects varied as follows: Model 1 included only grade as a random factor, and Model 2 added school as a random factor. Model 3 included grade, school, and board as separate random factors. Model 4 had grade as one random factor and school nested within school board as another random. ANOVA showed that Model 1 had the highest AIC and BIC, indicating the poorest fit. Model 2 showed improvement, but Model 3 (AIC: −2022.3, BIC: −1912.0, logLik: 1031.2) and Model 4 (AIC: −2031.5, BIC: −1921.2, logLik: 1035.8) provided the best fits. Although Model 4 had slightly better fit statistics, a likelihood ratio test showed no significant improvement ($\chi^2 = 9.22$, $df = 0$, $p > 0.05$). Therefore, Model 3 was selected for its balance of fit and simplicity.

Subsequently, another model (Model 5) was built to include only significant variables while retaining the same random effect structure as Model 3. This refinement aimed to improve simplicity and parsimony. ANOVA results showed that Model 5 demonstrated a better fit compared to Model 3, confirming that this refinement improved the model's effectiveness. Thus, Model 5 was retained as the optimal model, and its results are described below.

Data analysis: RQ2

Having identified significant predictors in Model 5, we then tested for potential interactions between these predictors and language of instruction. Testing for interactions helps

uncover any conditional relationships that might exist between language and the other significant factors, providing a more nuanced understanding of how language influences Level 3/4 achievement under different conditions. The inclusion of interaction terms allows us to examine whether the impact of language is moderated by factors such as per-student funding, urban factor, the percentage of participating students identified as having special education needs, or any other significant variables identified in the refined model.

To determine the best random effects structure and assess model fit, we compared three LMM: Model 6, which included fixed effects for interactions between *language* and significant covariates with a random intercept for *grade*; Model 7 added a random intercept for *schoolname* on top of Model 6's structure, while Model 8 further included a random intercept for *boardname*. Model 7 showed a significant improvement over Model 6 (AIC: −1907.5 vs. −1853.8, BIC: −1845.7 vs. −1797.7, $\chi^2 = 55.68$, $p < 0.001$). Model 8 demonstrated an even better fit with a lower AIC (−2177.5), BIC (−2110.2), and a higher log-likelihood (1100.77). The addition of the *boardname* random effect was highly significant ($\chi^2 = 272.06$, $p < 2.2e\text{-}16$). A model with *schoolname* nested within *boardname* did not converge, confirming that Model 8 provides the best fit while accommodating the data's hierarchical structure.

Content analysis

To examine the potential influence of language on the EQAO process, we conducted a supplementary content analysis of bilingual EQAO administration guidelines, which are available for the reference of teachers and school administrators. In particular, the content analysis focused on (1) sample letters, which serve as exemplars for the letters schools send to parents prior to each EQAO assessment period, (2) checklists, which provide teachers with specific tasks to complete in the administration of EQAO tests, and (3) sample scripts, once again exemplars for the instructions teachers read to students immediately before a test. According to an EQAO representative, consultation of the latter two resources is among teachers' professional responsibilities, whereas letters are sent off by schools rather than by individual teachers. The letters examined consisted of (1) a sample pre-administration letter, (2) an accommodation letter, (3) a sample ELL letter, and (4) a sample exemption letter. These various resources are components of the EQAO Knowledge Base, a regularly-updated repository of instructions for those involved in the administration of EQAO tests. Letters, checklists, and scripts were chosen as the focus of the content analysis as they are likely the most frequently consulted resources in the EQAO Knowledge Base, thus having the largest potential effect on the way in which EQAO assessments are administered and student achievement.

For the content analysis, five bilingual coders, all of whom being educators with university-level education, were asked to complete a survey. The survey presented excerpts from the English and French versions of EQAO instructions side by side; in each excerpt, the selection of text deemed by the researcher to be particularly different between languages was highlighted. Next to each excerpt was a checkbox for coders to check if they agreed that the potential difference was significant: i.e., that it was likely to change how teachers of different language

systems interpret the instructions. There were also additional checkboxes for the coder to indicate the nature of the significant difference, listed as follows: word/phrase meaning, sentence meaning, word/phrase complexity (higher in English), word/phrase complexity (higher in French), sentence complexity (higher in English), sentence complexity (higher in French), detail (higher in English), detail (higher in French). Coders were asked to check boxes in this section only if they confirmed that the underlying difference is significant; they were also given the option to check multiple boxes if necessary.

The survey sent to coders was organized into the following sections: (1) Potential textual differences: Grades 3 & 6, (2) Potential textual differences: Grade 9, (3) Omitted text: Grades 3 & 6, and (4) Omitted text: Grade 9. The omitted text sections contained instances of instructional differences wherein text found in one language's instructions was not present in the other's. For each instance of omitted text, coders were asked to assess whether the absence of text highlighted by the researcher from one of the two languages significantly changes how the instructions might be interpreted. Though time constraints prevented the opportunity to analyze results, such as through an inter-rater reliability test, the data collected are available upon request and may be requested for future research endeavours.

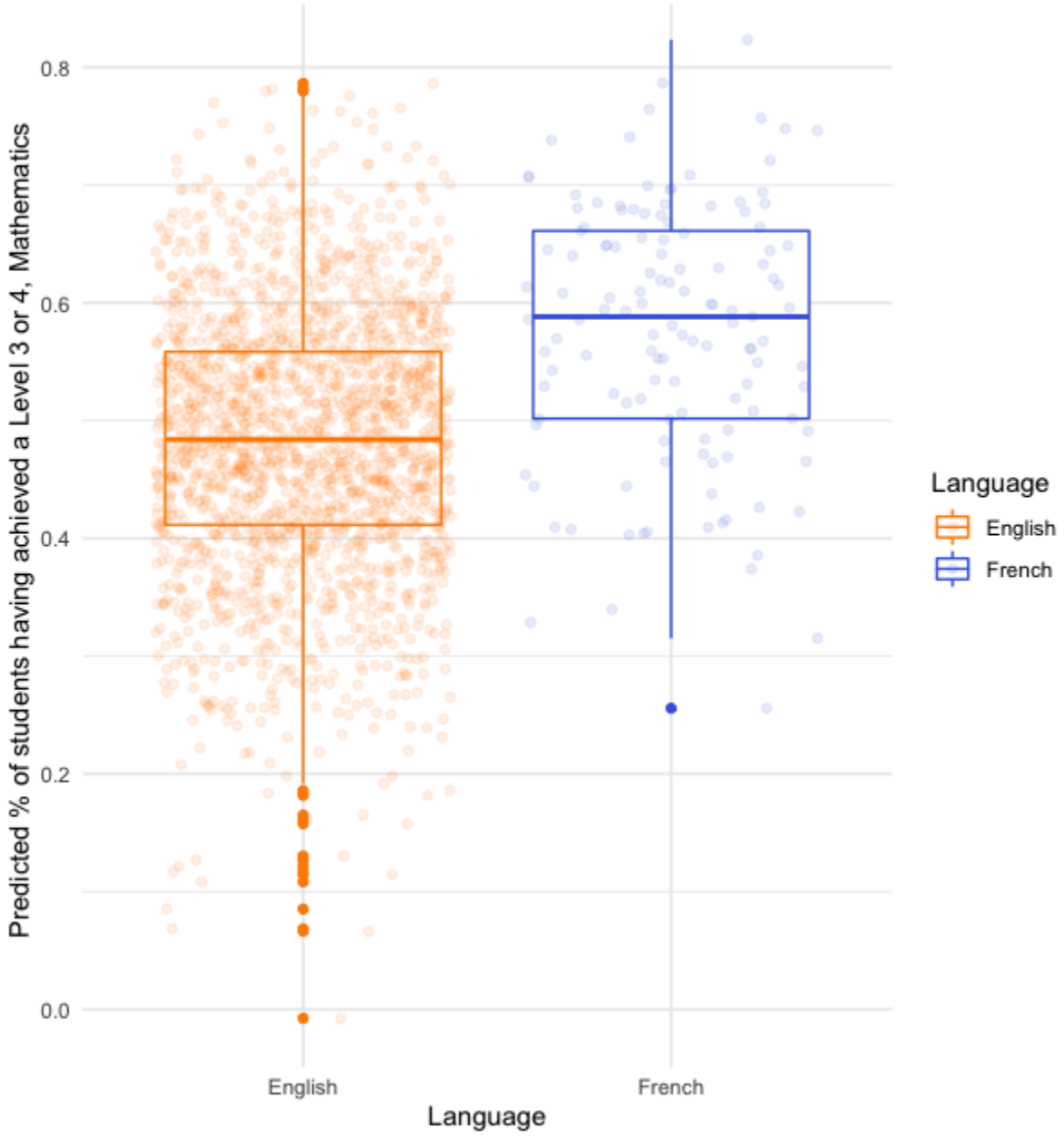
III. Results

In this section, we present the findings of our study, focusing on the comparative analysis of student achievement in EQAO math assessments between Ontario's English- and French-language systems. We begin by addressing RQ1, which examines the overall differences in achievement levels between the two language systems. Following this, RQ2 explores the interaction between language of instruction and the significant predictors of student achievement. Finally, we provide insights from the content analysis to complement the quantitative findings.

Differences in achievement by language system

Results from Model 5 revealed a significant effect of language (β = 0.12, 95% CI [0.06, 0.18], $p < 0.001$), as shown in Figure 1. The figure illustrates the model-predicted percentages, indicating that the proportion of students achieving either Level 3 or Level 4 was higher in French-language schools (60%) compared to English-language schools (54%).

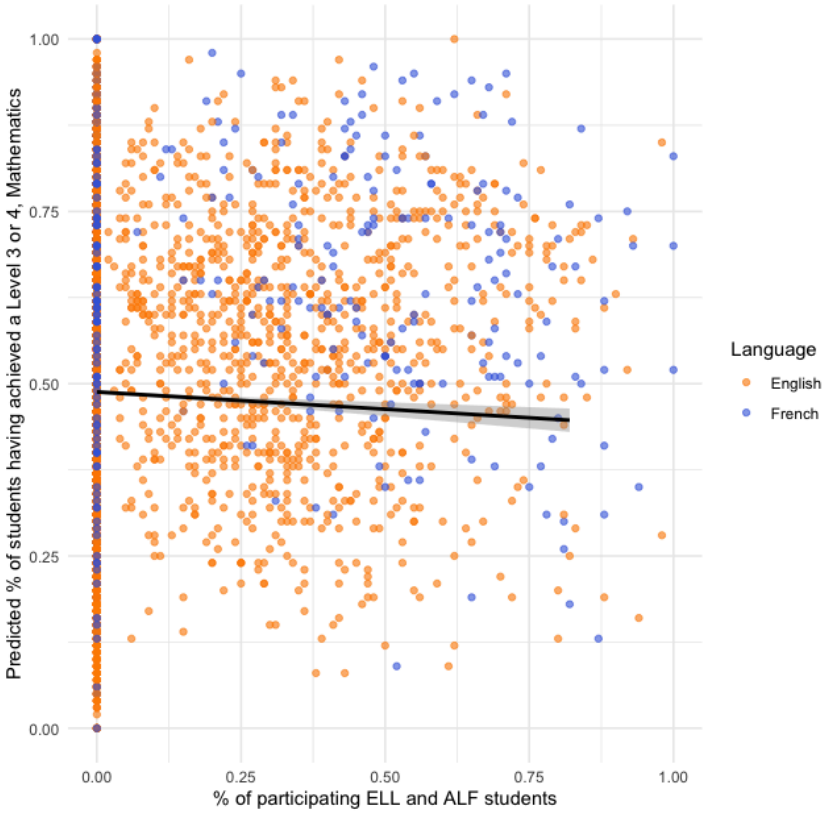
Figure 1. Boxplot of Predicted Percentage of Fully Participating Students Achieving Level 3/4 in EQAO Math Assessments by Language



The analysis also revealed significant predictors of Level 3/4 achievement, including the combined percentages of students eligible to receive ELL or ALF supports (pctELL_ALF) (β = −0.14, 95% CI [−0.20, −0.08], $p < 0.001$), the percentage of students with special education needs (pctSpecialNeeds) (β = −0.62, 95% CI [−0.68, −0.55], $p < 0.001$), and the percentage of students born outside Canada (pctBornAbroad) (β = −0.15, 95% CI [−0.22, −0.09], $p < 0.001$), and the normalized per-student funding (perstudentfunding_normalized) (β = −0.24, 95% CI [−0.38, −0.10], $p = <0.001$). Figure 2 below illustrates these results. The model's random effects showed an ICC of 0.51, indicating that 51% of the variance in Level 3/4 mathematics achievement is attributable to differences between schools and school boards. The model explained 16.6% of the variance marginally (i.e., by the fixed effects alone) and 59.5% conditionally (i.e., by the fixed effects plus the random effects).

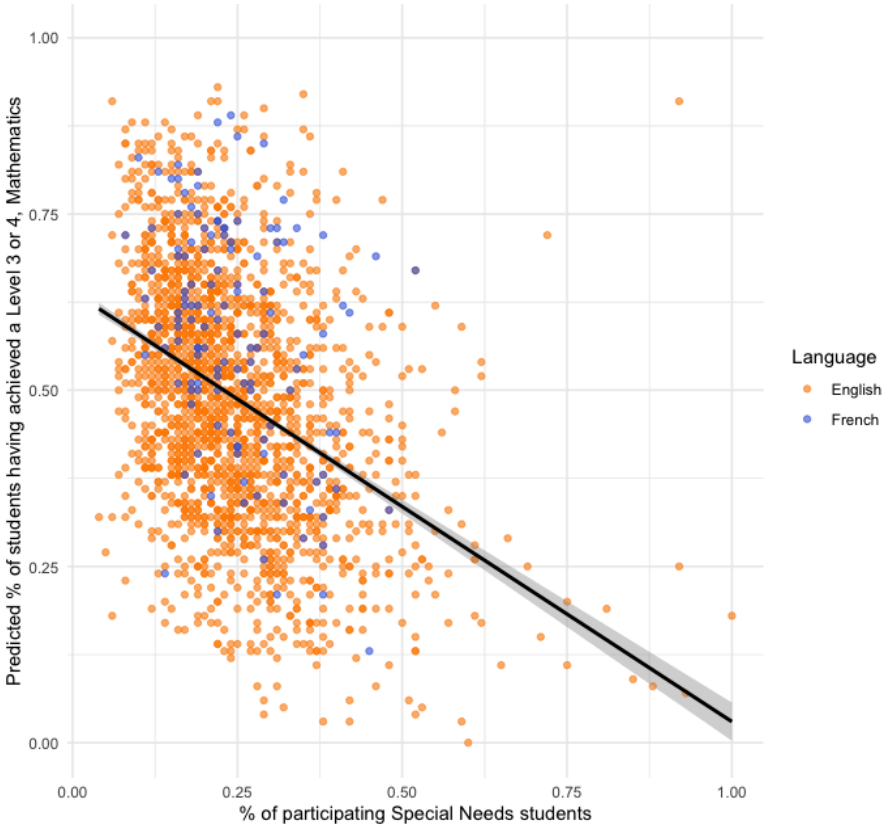
Figure 2. Differences in Level 3/4 Achievement for Variables (a) *pctELL_ALF*, (b) *pctSpecialNeeds*, (c) *pctBornAbroad*, and (d) *perstudentfunding_normalized*

(a)



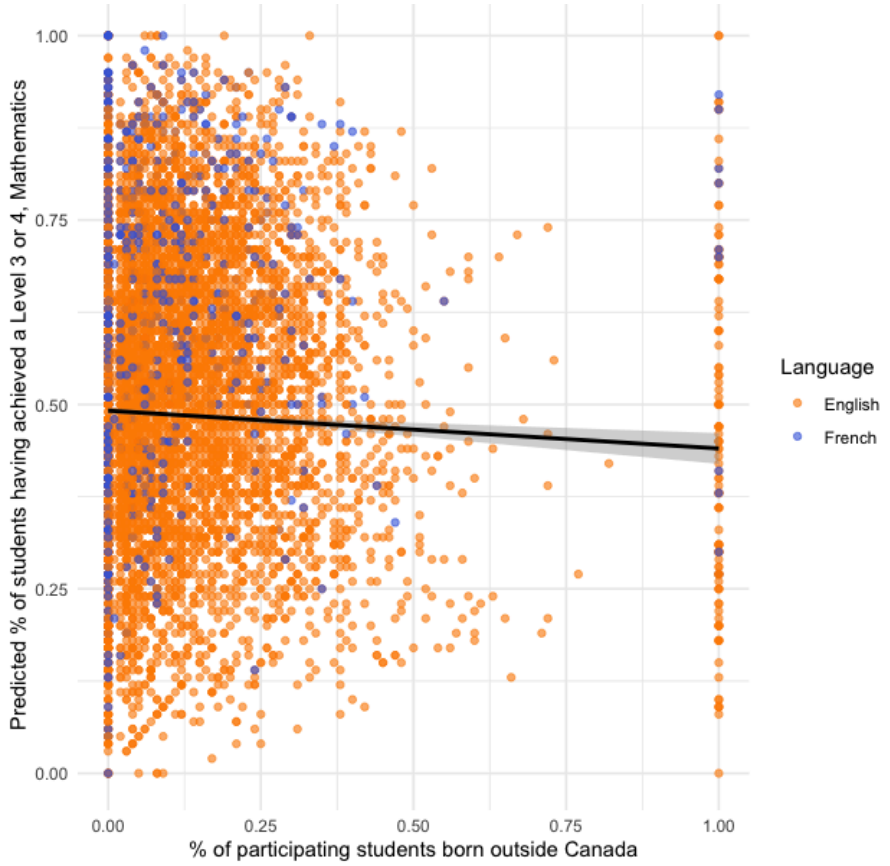
In the above graph, as the proportion of fully participating students who are eligible to receive ELL or ALF supports increases, there appears to be a slight decrease in the percentage of students having achieved a Level 3/4 on their respective EQAO math assessments.

(b)



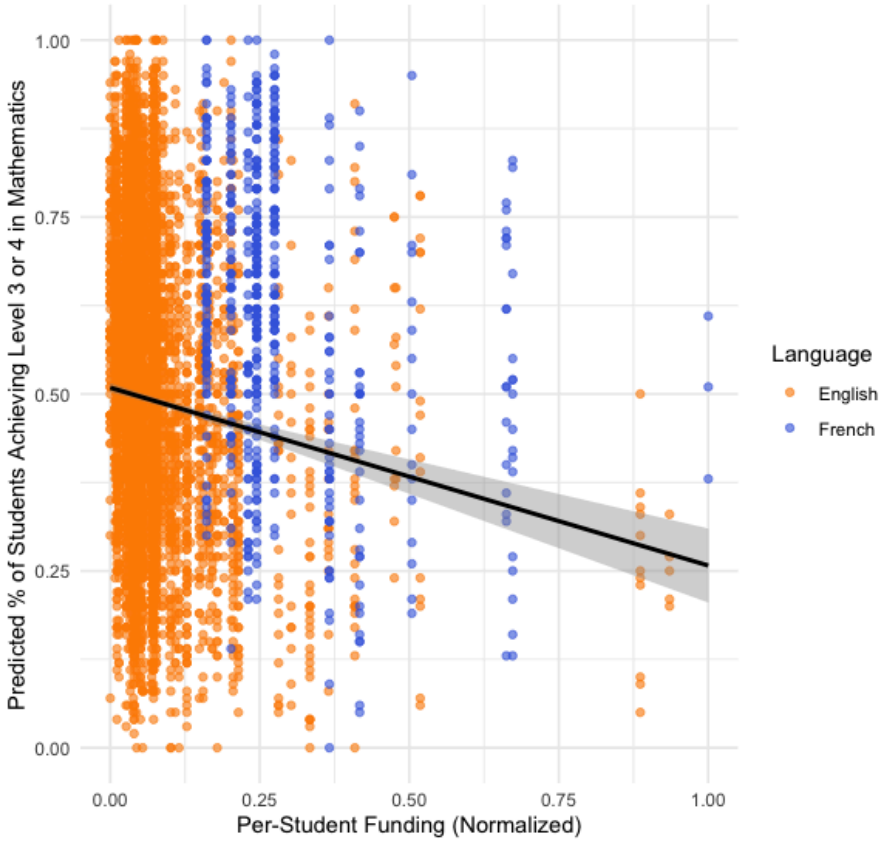
Here, as the proportion of fully participating students identified as having special education needs increases, we observe a rather steep decrease in Level 3/4 achievement.

(c)



Another very slight decrease in Level 3/4 achievement can be seen as the proportion of fully participating students who were born outside of Canada increases.

(d)

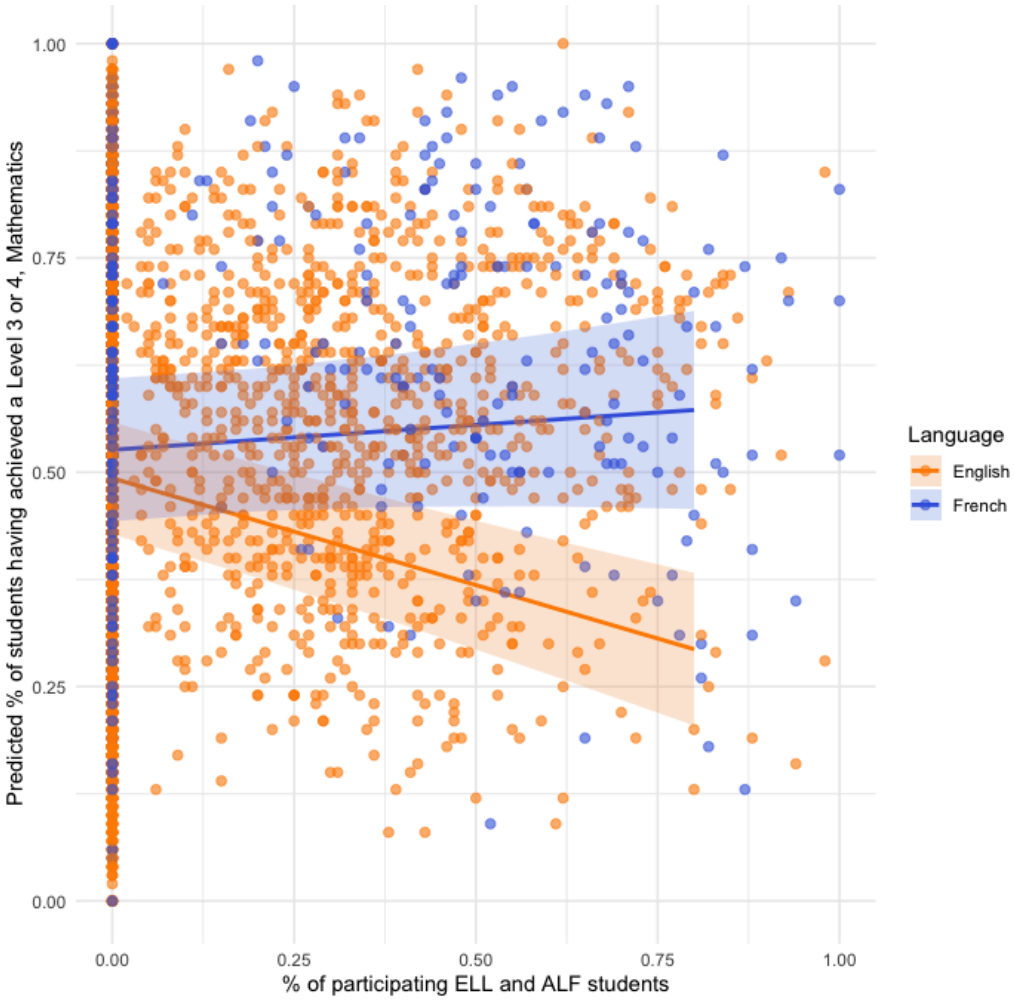


Finally, and rather unexpectedly, Level 3/4 achievement seems to noticeably drop as normalized per-student funding increases.

Combined effect of language and ELL/ALF eligibility

Model 8 revealed a significant interaction between language of instruction and the proportion of students eligible to receive ELL or ALF supports. Specifically, the interaction term language * pctELL_ALF had a substantial effect ($\beta = 0.31$, 95% CI [0.17, 0.45], $p < 0.001$). This interaction is illustrated in Figure 3 below.

Figure 3. Scatterplot of Interaction Between *language* and *pctELL_ALF*



These results indicate that the impact of language of instruction on Level 3/4 achievement depends on the proportion of students with ELL or ALF eligibility. While French-language schools generally demonstrate higher Level 3/4 achievement than English-language schools, this advantage is moderated by the percentage of students eligible for such supports. That is, as the proportion of ALF-eligible students increases, so too does Level 3/4 achievement. Conversely, as the proportion of ELL-eligible students increases, Level 3/4 achievement decreases. Furthermore, the analysis revealed that 53% of the variance in Level 3/4 achievement is attributed to differences among schools and school boards, as indicated by an Intraclass Correlation Coefficient (ICC) of 0.53. The remaining 47% of the variance is explained by our IVs, including the percentage of English Language Learners (ELL), students with special education needs, and students born abroad. The model explains 15.9% of the variance with fixed predictors alone (marginal R^2) and 60.4% when accounting for both fixed and random effects (conditional R^2).

IV. Discussion

Two research questions guided this study's analysis. Firstly, RQ1 aimed to determine whether achievement on EQAO math assessments was significantly different between English- and French-language systems for the recent 2022–23 assessment period. In other words, we sought to model the effect of language (the primary IV) on Level 3/4 achievement (the DV). Once a significant difference was identified, RQ2 then sought out to examine any potential interactions between language of instruction and various IVs thought to influence student achievement.

The findings of RQ1 at once seem to contradict previous studies on gaps in the quality of English–French education and corroborate studies on the predictors of student achievement. Several studies from the 2000s noted the many challenges faced by French-language schools in Ontario, from limited cultural immersion (Gilbert et al., 2004; Prasad, 2009) to relatively poor instructional quality and a lack of resources (Dénommé, 2006; Dénommé & Childs, 2008). Dénommé (2006) in particular supplemented such qualitative findings with quantitative data on student achievement in PIRLS, an international assessment, which showed that French-language students achieved below English-language students across almost all assessment components in 2001. Our findings, however, found that French-language schools achieved significantly higher on provincial EQAO math assessments in the 2022–23 assessment period, 22 years later. This development may have partially resulted from the Province's increased investment in French-language schools from the 2000s onward, which can also explain FAO's finding that French-language schools generally have higher per-student funding than English-language schools. Historically, it would appear that the Province's policy initiatives dedicated to the improvement of French-language education have been fruitful.

Regarding students with special education needs, the study's results support prior findings by Schulte & Stevens (2015) and Vincett (2016), which indicate that these students tend to achieve lower on standardized assessments (Schulte & Stevens, 2015; Vincett, 2016). This highlights the need for timely interventions, as the data suggest that current supports may be insufficient to fully close these gaps. The literature also notes that some students are not identified as having special education needs and therefore miss out on receiving an IEP. Simultaneously, the significant school-level variance (ICC of 0.53) suggests that broader systemic factors may also play a crucial role in these outcomes, beyond individual student characteristics.

Per-student funding as well as the proportion of participating students who were born outside Canada were also found to be significant. Unexpectedly, Level 3/4 achievement tended to decrease as per-student funding increased, which contests the claim that the higher achievement of French-language schools is due to increased funding. Alternatively, it is possible that the recent adoption of the novel Core Ed funding model accounts for this trend, though more research is needed in this area to confirm or refute this. Achievement similarly decreased across language systems as the percentage of participating students born abroad increased. This

supports findings by Fox & Cheng (2007) that, early on, students who speak neither English nor French tend to underperform in standardized assessments (Fox & Cheng, 2007). This result may also highlight relationships between variables such as race, ethnicity, socioeconomic status, and native language as they pertain to student achievement. Further investigation into these factors could provide more insight into how funding models and demographic characteristics impact educational outcomes.

The significant interaction observed between language of instruction and the proportion of ELL- or ALF-eligible students also has interesting implications. This suggests that the relative advantage observed in French-language schools may be moderated by the demographic composition of their student populations. For instance, while French-language schools appear to have benefited from increased funding and targeted educational policies, the presence of a higher proportion of students requiring ELL or ALF supports can reduce this advantage, potentially widening the achievement gap between language systems. Despite widespread recognition in literature of the unique obstacles ELL students face, which often have the potential to limit their academic achievement, it was previously unclear whether these difficulties extend to math assessments. This study's findings suggest that such challenges do indeed affect math achievement and are not confined to literacy-based subjects.

When assessing the interaction between language of instruction and the proportion of students who are ELL- or ALF-eligible, it is important to consider how the demographic characteristics of student populations they serve can influence differential outcomes in these support programs. Being enrolled in Ontario's French-language school system, for instance, many students eligible for ALF supports are presumably rights holders, meaning they are likely to have some exposure to French as a heritage language even if it is not their dominant language. Receiving ALF supports could therefore reinforce these students' linguistic and cultural ties to French, providing more opportunities to use the language at home, in the community, and at school. This greater immersion may better prepare ALF-supported students for success in the French-language education system.

In contrast, students in English-language schools who receive ELL supports often speak a minority language (e.g., Korean, Mandarin, Punjabi) natively, which they may use at home and within their communities. Despite receiving ELL supports, these students' exposure to English outside of school may be limited. In addition, English-language schools often offer French Immersion programs, and it is possible that some ELL students are also enrolled in these programs. If so, learning French in a more immersed setting could potentially slow their progress in English, further complicating their language development and academic achievement. In future studies, it would be interesting to explore patterns of language input and use among these students to determine whether they correlate with overall level of achievement.

Limitations

This study's findings should be interpreted with careful consideration of its methodological limitations. Due to the challenges of comparing pre- and post-pandemic EQAO

achievement, the LMM relied on data collected from single assessment periods rather than longitudinal data. While this approach was a necessary precaution, it may have resulted in less robust data than a longitudinal analysis would provide. Additionally, the fact that the two data sets combined in this study represent different assessment periods (2021–22 for FAO and 2022–23 for EQAO) may have affected the accuracy and validity of our findings. These two data sets also differ in scope, with FAO's data covering school boards and EQAO's data focusing on individual schools. As a result, variables obtained from the former were applied to multiple schools, serving as an approximate representation of each and thus lacking the precision of the EQAO data.

The content analysis component of this study also has its limitations. For one, it was restricted in scope, covering only letters, checklists, and scripts at the exclusion of resources such as curriculum documents, EQAO-led webinars for teachers, and the remaining administration guidelines in the EQAO Knowledge Base. Reviewing English- and French-language curricula is especially important for understanding the influence of instructional differences on perceived achievement gaps, though this was not included due to time constraints. Furthermore, although five coders were consulted to assess the significance of each excerpt in the content analysis, the principal researcher alone identified potentially significant excerpts. This may have led to some significantly different excerpts between languages not being brought to the attention of the coders. Given that the researcher provided the coders with only the context deemed necessary, some contextual information that could have influenced their decisions may have been omitted. Finally, some sentences were cut short at the researcher's discretion, potentially limiting the coders' ability to fully discern syntactical differences and variations in meaning at the sentence and paragraph levels.

V. Conclusion

In this study, we comparatively analyzed student achievement on EQAO math assessments between Ontario's English- and French-language systems for the 2022–23 assessment period. We also investigated ten variables thought to influence the observed achievement gap, using a linear mixed-effects model to test the significance of each. Our findings indicated that French-language schools had a higher percentage of students having achieved Levels 3 or 4 on math assessments compared to English-language schools, with the difference being statistically significant. We also identified four significant independent predictors of achievement—the percentages of students eligible to receive ELL or ALF supports, students with special education needs, students born abroad, and per-student funding—with varying effects on Level 3/4 achievement. The most interesting finding, however, was that the effect of language is moderated by the proportion of EQAO-participating students eligible to receive English Language Learner (ELL) or *Actualisation Linguistique en Français* (ALF) supports. A supplementary content analysis further revealed the potential influence of linguistic

differences in bilingual test administration guidelines, which the EQAO makes available to teachers and school administrators.

Through this research, we seek to bridge a gap in literature by directly comparing EQAO achievement across language systems. Although unaffiliated with EQAO, our study aligns with the organization's objectives of promoting accountability in education and better understanding the most pertinent predictors of student achievement. Because student achievement data is used by the Province to assess the extent to which students can retain curriculum information and effectively demonstrate their knowledge, identifying such predictors is necessary to meet these goals. By providing additional context to EQAO's raw data, this study therefore supports educational administrators in responding to the diverse needs of Ontario students. Finally, the relationships identified among relevant variables support the findings of existing research while laying the groundwork for future studies on similar topics. Going forward, more research on the ALF program in Ontario's French-language system may be valuable to discussions of the English–French achievement gap. Researchers must also be mindful of factors such as EQAO's multi-stage computer adaptive testing model and the Province's Core Education Funding system, interpreting existing data and the findings of older studies with these modern developments in mind. As EQAO assessments evolve, continued research into the English–French achievement gap is crucial to fully understand and address disparities in student outcomes.

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