# What Factors Affect Israeli 8th Graders' Math Achievement? — A Two-Level Hierarchical Linear Model (HLM) Analysis

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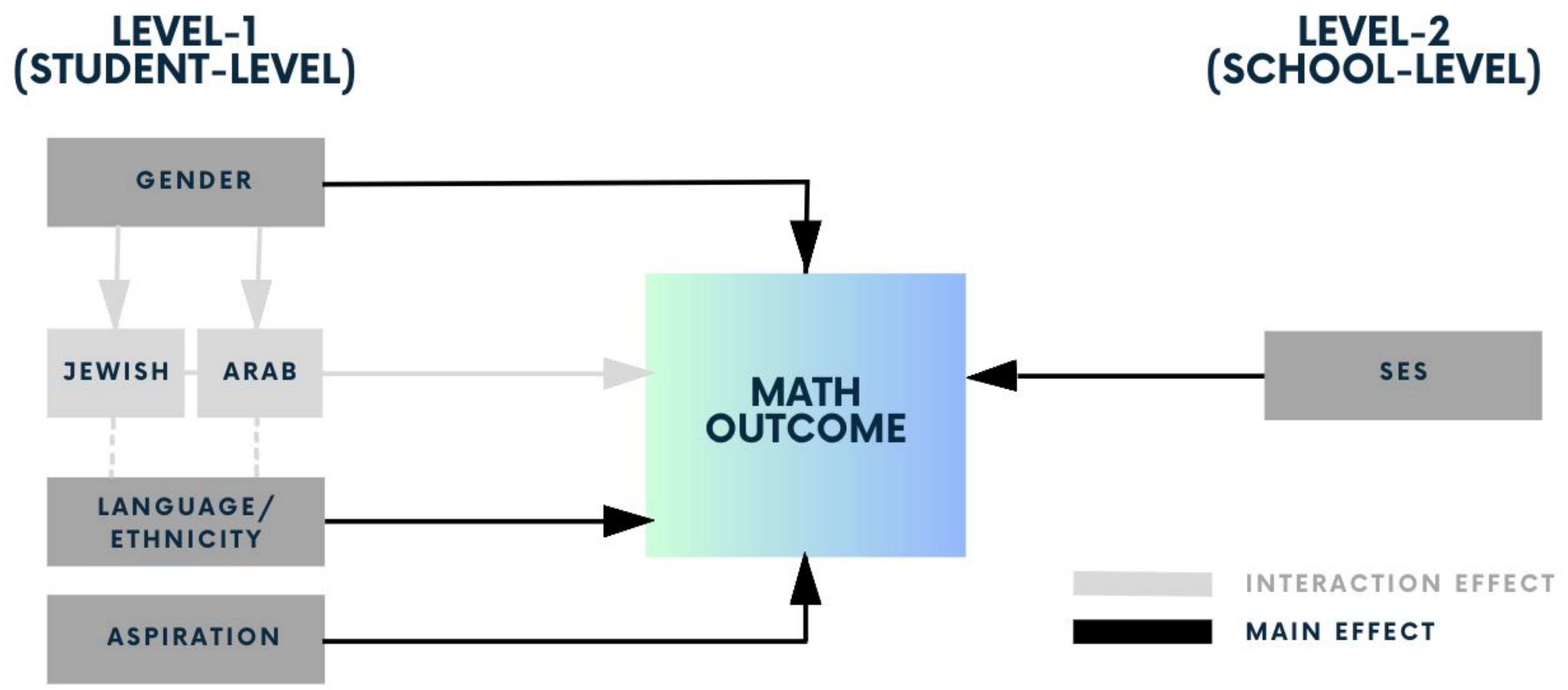
## Abstract

The purpose of this study is to investigate the effects of school-level socioeconomic status as well as student-level factors, including gender, ethnicity and aspiration for future education have on math achievement among Israeli 8th-grade students. Additionally, the interaction effect between gender and ethnicity is also examined at both levels. Through Hierarchical Linear Model (HLM) analysis of TIMSS 2019 data, the study finds that math achievement is strongly associated with percentages of economically disadvantaged students at the school-level and students' aspiration for future education. While the gender variable alone does not significantly affect math scores, results indicate that boys' advantages in math exist more in the Jewish educational sector.


## Conceptual Framework and Research Questions




1) To what extent does Israeli 8th-grade students' math achievement vary among schools and within schools in Israel?
2) To what extent do the effects of student-level (level-1) variables (gender, language, educational aspiration) and to what extent the % of economically disadvantaged students at school (level-2 variable) are associated with Israeli 8th-grade students' math performance in TIMSS 2019?
3) To what extent does the effect of gender differ by language and ethnicity (between Jewish and Arab students)?

## Methods

Since individuals are nested within groups (ie. students nest within schools), HLM is used as an alternative method of traditional 1-level linear model. Its benefits include:

1) being able to avoid mixing individuals or groups as the unit of analysis,
2) dealing with more complicated sampling strategies,
3) generating more accurate estimates of parameters, and
4) enabling researchers to analyze more complex questions across groups.

**A: The unconditional model**
for student i in school j is explained by the equation:

$$\text{Mathscore}_{ij} = \gamma_{00} + u_{0j} + \varepsilon_{ij}$$

**β** is the school mean for dependent variable. $\gamma$ in the equation is the grand-mean of math scores across schools, and u is the variance in school mean from the grand mean. $u_0$□ is the variance between groups and $\varepsilon_0$□ is the variance within groups, they provide measure of intraclass correlation (ICC). Large ICC means high similarity in math scores between schools.

**B: Student-Level Model (Level-1 Random Intercept Model)**

$$ICC = \sigma^2_{u0j} / \sigma^2_{\varepsilon ij} + \sigma^2_{u0j}$$

**C: Teacher-Level Model (Level 2 Random Intercept Model)**

$$Mathscore_{ij} = \gamma_{00} + \gamma_{10}\, Male_{ti} + \gamma_{20}\, Hebrew_{ti} + \gamma_{30}\, Eduaspiration_{ti} + \gamma_{40}\, Gender * Eduaspiration_{ti} + \gamma_{60}\, Language * Eduaspiration_{ti} + \varepsilon_{ij} + u_{0j}$$

the reduction in variance estimate for the within-group and between-school is:

$$Mathscore_{ij} = \gamma_{00} + \gamma_{01}\, \text{Econdis}_j + \gamma_{10}\, Male_{ti} + \gamma_{20}\, Hebrew_{ti} + \gamma_{30}\, Eduaspiration_{ti} + \gamma_{40}\, Gender * Eduaspiration_{ti} + \gamma_{50}\, Language * Eduaspiration_{ti} + \varepsilon_{ij} + u_{0j}$$

the reduction in variance estimate for the within and between school:

$$(\sigma^2_{m1} - \sigma^2_{m2}) / \sigma^2_{m1}$$

## Results

| | Model A | | Model B | | Model C | |
|---|---|---|---|---|---|---|
| | Standardized coefficient | Std.Error | Unstandardized coefficient (Standardized coefficient) | Std.Error | Standardized coefficient (Standardize d coefficient) | Std.Error |
| Intercept | 516.07 | 70.07 | 456.66*** | 63.01 | 481.85*** | 60.46 |
| **Level-1 Predictors** | | | | | | |
| Hebrew | - | | 35.81*** (6.04) | 10.63 | 2.49 (0.47) | 11.39 |
| Male | - | | -6.140 (-0.41) | 4.26 | -6.46 (-0.35) | 4.28 |
| Eduaspiration | - | | 36.95*** (1.60) | 2.73 | 36.75*** (12.33) | 2.73 |
| Language * Gender | - | | 20.36*** (1.68) | 5.21 | 20.62*** (1.78) | 5.23 |
| **Level-2 Predictor** | | | | | | |
| Meanecondis | - | | - | - | -29.77*** (-2.37) | 4.82 |
| **ICC** | 47.4% | | 39.0% | | 38.4% | |
| **Amount of Variance Explained by the Model** | | 39.1% (Between) | | 46.8% (Between) | | |
| | | 14.5 (Within) | | 4.96 (Within) | | |

**Note:**
***p<0.05, **p<0.01, ***p<0.001 Variables have been grand mean centered**
**Standardized Coefficients are in parenthesis**

- Average math scores that students receive **vary** across schools and within school units
- **Positive relationship** between student's educational aspirations and math. **Negative relationship** between % economically disadvantaged students and math
- The effect of **gender varies when taking ethnicity/ language** into consideration. Boys' advantages in math exist more in the Jewish educational sector, which resonates with the findings in Zuzovsky, 2001
- the effect of language is significant in the first level, but becomes no longer significant when adding school SES

## Acknowledgements

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