



Does class matter more than school? Evidence from a multilevel statistical analysis on Italian junior secondary school students



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ABSTRACT

This paper assesses the differences in educational attainments between students across classes and schools they are grouped by, in the context of Italian educational system. The purpose is to identify a relationship between pupils' reading test scores and students' characteristics, stratifying for classes, schools and geographical areas. The dataset contains detailed information about more than 500,000 students at the first year of junior secondary school in the year 2012/2013. By means of multilevel linear models, it is possible to estimate statistically significant school and class effects, after adjusting for pupil's characteristics, including prior achievement. The results show that school and class effects are very heterogeneous across macro-areas (Northern, Central and Southern Italy), and that there are substantial discrepancies between and within schools; overall, class effects on achievement tend to be larger than school ones.

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1. Introduction and motivation

The analysis of the differences in educational attainments between groups of students and across schools and classes is still attracting the attention of scholars of various disciplines. Studies on this topic are carried out in order to test and improve the educational system and to understand which variables mostly affect it (see Refs. [20,28,64]). In a policy perspective, the academic contributions in the field would understand whether attending a specific school makes a difference for current and future students' performances. For instance, Raudenbush & Bryk (see Ref. [51]), were among the first studying the effect exerted by attending a specific school on student achievement, by means of a multilevel model (and a recent re-analysis of traditional results of the Coleman Report's data to study the relative effects of family's background and school effects is in Ref. [31]); while the seminal studies of Card & Krueger (see Ref. [14]), and Betts (see Ref. [9]) examined the relationship between the characteristics of schools attended and subsequent earnings. In this

context, the particular attention also at classroom-level phenomena is also corroborated by recent contributions that demonstrate that class-specific effects (see, for instance [13], on class-level peer effects).

In Italy, the Italian Institute for the Evaluation of Educational System (hereafter INVALSI), founded in 2007, assesses students in reading and mathematics abilities at different stages, by means of standardized tests: at the end of the second and fifth year of primary school (when pupils are aged 7 and 10, respectively), at the end of the first and third year of lower secondary school (aged 11 and 13) and at the end of the second year of upper secondary school (aged 15).

Students are requested to answer questions (the same for everyone) with both multiple choices and open-ended questions, that test their ability in reading and mathematics. This is a way to test knowledge and reasoning that pupils should have learned in their school career. Also, they are requested to compile a questionnaire about themselves, their family, their parents' educational level and their socio-economic situation, with the aim of building and indicator about their background (namely ESCS; Economic, Social and Cultural Status). By means of this kind of information and of the use of multilevel linear model, it is possible to investigate the relationship between students' characteristics and performances and to define the school/class “impact”, that is the effect

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exerted by attending a specific school/class on its students' achievements.

Studies on the mathematics achievements have been previously conducted (see Ref. [1]), applying multilevel linear models (see Refs. [21,22,46]); they allow to identify clear relationships between individual students' characteristics and achievements. For example, it emerged that females have worse average results than males, 1st and 2nd generation immigrant students have lower average performances than native Italian students, being early/late-enrolled students decreases the average results, students with a high level of socio-economical status have better performances than students with a lower one, and much more. Big differences exist between North, Center and South of Italy: students attending schools in the North obtain higher scores, all else equal, reinforcing the need for further exploring the differences across countries' geographical areas (see Refs. [4,37,59]) – a topic that is explicitly modeled in the present paper. Moreover, despite the institutional organization of the Italian educational system is based on strong assumptions about its equality purposes, based on the presumption that all schools/classes provide similar educational standards, these studies empirically proved that this is not true and that actually the country's educational system is characterized by a 'learning divide'.

In this paper we focus on the reading achievements and we deepen the understanding of school and class effects, with the broad objective of exploring if school and class effects are simultaneously impacting the achievement levels of students, and which of the two is eventually prevailing. The specific research questions are: (i) which is the relationship between pupils' characteristics, such as profile, socio-cultural background, household, cultural resources, and pupils' achievement? (ii) are there heterogeneous educational differences between different schools/classes and between the three geographical macro-areas of Italy (Northern, Central and Southern)? (iii) How the school/class effect is less/more pronounced for specific types of student profile? The main statistical tools employed in this kind of analysis are multilevel linear models (see Ref. [11]).

The work is organized as follows: Section 2 presents the dataset; in Section 3 we fit a three-level linear model for the reading achievement, in which pupils are nested in classes, that are nested in schools, in the three geographical areas; in Section 4 we analyze the school and class effects and we compare them; Section 5 contains discussion and conclusions.

All the analyses are made using the statistical software R (see Ref. [50]).

2. Theoretical framework and related literature

The present study deals with the general aim of identifying the effect of attending a specific school/classroom on the students' achievement, as measured through test scores. In this perspective, three streams of related literature influence our theoretical frame and empirical approach.

The first strand is the traditional statistical analysis of educational data (see Refs. [24,11]), which suggests the use of multilevel models for isolating the so called "school effect" from the other factors influencing the students' experience and results – typically, their (socioeconomic) background and (territorial's) contextual variables (see Ref. [52]). Many pioneering researches, in this context, did focus on data about single countries, and evidenced how variability of students' scores is much wider within schools than between them, and that the role of schools in determining such scores is lower than that attributable to students' individual characteristics. For instance, Mickelson et al. (2013, see Ref. [38]) conducted a meta-analysis of existent

evidence about the racial achievement gap in US primary and secondary schools, by means of a two-levels hierarchical model, and highlighted that such gaps widen in higher grades. Thieme et al (2013, see Ref. [61]), in a recent contribution, combined multilevel modeling techniques with frontier methods for studying the performance of a sample of Chilean fourth grade students. Their findings discuss how inadequate statistical analysis would attribute low performance due to out-of-control factors to school effects – so calling for using better methods for disentangling environment, schools and student-related factors. Sun et al. (2012, see Ref. [60]) use PISA 2006 data to explain the main factors associated with the science achievement of fifteen-years old students in Hong Kong, and while acknowledging the preeminent role of individuals' characteristics, they find how schools' SES composition and instruction time per week do play a differential role for students attending different schools. Benito et al. (2014, see Ref. [7]) present an application of the multilevel approach to an international perspective, with the aim of comparing the influence of system-level and school-level inequalities on students' performances in 16 countries' educational systems.

Following this broad area of academic research, we opted for implementing a three-levels multilevel model for studying simultaneously the role of students' characteristics, together with those of the class and school they are attending. Specifically, the idea of focusing on the classroom as the unit of analysis where a strong influence on students' results is exerted, is in line with those contributions in the educational psychology literature that emphasizes classroom-level features such as the 'climate' (see Ref. [53]) – in the same vein, an interesting paper by Martinez (2012, see Ref. [35]) shows how distorted can be those multilevel estimations of students' results that omit classroom-level mediating effects.

The second group of studies, which are directly connected to the present work, is the one inserted in the economics of education literature about the effect of specific schools' features on the students' performances, and more generally to the specification of an Educational Production Function (EPF) that can describe the process that leads some combinations of (human and material) inputs to 'produce' educational outputs (see Ref. [49]). The most noticed studies, in the field, are those that investigate whether school resources are statistically correlated with student achievements' differentials – or even cause them. In particular, many works conducted by prof. Hanushek (Stanford University) provoked a great debate among academics and practitioners, suggesting that higher levels of (school) resources are not associated with higher educational outputs (see, among many others [25–27]). Therefore, a huge debate exists about the role of resources on education (see Ref. [5]), and some authors – criticizing Hanushek's approach – demonstrate that higher levels of resources are instead associated with better outcomes, if modeling is built in an adequate way (see, for instance [32], on class size) – for evidence about school resources and educational output in UK, see Refs. [34,58,29]; for a survey of literature until early 2000s, see Ref. [64]. A recently growing attention is being paid to the role of school principals and school practices in influencing students' results¹ (for instance, Bloom et al., 2015 (see Ref. [10]) apply a theoretical framework from management science to describe principals' managerial behavior, and show how these are associated with different school performances). In addition, some studies in the field use statistical models for testing the effects of certain policies – as an example, Osht et al.

¹ In addition to the role of principals and processes on students' results, some studies also looked at the impact on other outcomes/features, such as teachers' satisfaction – for an application of multilevel models to this latter setting, see Ref. [57].

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